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OUR "NOTES FROM ABROAD," in the issues of Oct. 25 and Nov. 1 contain two typographical errors. The mixed gauge of the Great Western Ry. (England), referred to on page 375, is 7 ft. and 4 ft. 8½ ins., and not 7 ft. and 7 ft. 4½ ins., as stated. On page 399, 25th line from bottom, for "brake and lock" read "brake block," which is the English term for brake-shoe.

THE RAILWAY TRAFFIC RETURNS FOR BOSTON, Mass., according to the Massachusetts Railroad Commission in its last report, show an aggregate of 48,072,299 persons passing to and from Boston in the year ending June 30, 1890, an average of 131,700 for each of the 365 days. The Boston & Maine R. R carried 19,602,017 of this total, and the Old Colony came next with 12,543,944. The first named road operated 1,210 miles of track in three States, 472 miles being in Massachusetts. It transported a total of 29,613,549 passengers, an increase of 5.37 % over the year 1888-89. These passengers rode an average distance of 13.22 miles, and paid for passage $7,128,449 or an average of 24 cts. per passenger. The Old Colony R. R. has a total mileage of 563.55 miles, all but 6 miles in the State. This system carried 21,305,226 passengers, an increase of 7.14 % over 1888-89; the average haul per passenger was 11.7 miles, and the company was paid $4,541,061 for passage, or an average of 21.31 cts. per person. The Boston & Albany R. R. operated 388.73 miles (332.1 miles in Massachusetts), carried 11,002,597 passengers an average distance of 18.28 miles, and received in passage money $3,737,203, or about 34 cts. per passenger. The New York & New England R. R. operated 465.2 miles of road, and transported 7,637,290 passengers an average distance of 13.42 miles, and received $2,004,655 passage money, or 21.3 cts. per passenger.

THE BOYNTON BICYCLE system of operating railways is to be adopted by the Kansas City, Watkins & Gulf R. R. Co. on its new line from Lake Charles, to Alexandria, La., 105 miles, according to press despatches. The bicycle system will be operated in connection with the ordinary system. A locomotive and several cars will it is stated, be ordered soon.

AIR BRAKES AND SAFETY COUPLERS have been put on all the freight and coal cars of the Iowa division of the Illinois Central Ry., as provided for by the Coffin bill passed by the last Iowa Assembly.

CABLE STREET RAILWAYS are proposed in London, England. The Highways Committee of the London County Council has agreed to an application being made by the London Tramways Co. to the Board of Trade for authority to use cable power on the company's line already constructed between Kennington and Brixton, and on the authorized extension to Streatham Hill.

THE ESSEX ST. ELECTRIC STREET RAILWAY CO., of Boston, Mass., voted on Oct. 28 to issue $100,000 for the construction and equipment of the line.

AN EXPERIMENTAL ELECTRIC RAILWAY, 2,784 ft. long, working on the principle of sucking the car as a magnet through a coil tube in which the current is continuously caused to circulate just ahead of the car, has developed 25 to 30 miles per hour under somewhat unfavorable circumstances, and is regarded as of much promise. The coils are of No. 14 copper wire, 20 lbs. per coil, placed at intervals of about 6 ft., varying somewhat with the grades and curves. The car is 12 ft. long, 10 ins. in diameter, and weighs 350 lbs., carried on two bicycle wheels turning on ball bearings. A 20 HP. dynamo wound for a pressure of 1,000 volts furnishes the power. Prof. A. E. DOLBEAR is electrician of the company; 120 miles per hour is aimed at and seems to be promised. The cost of construction for an express and mail line is estimated at $15,000 per mile. The experimental track is at Cambridge, Mass.

TRAIN LIGHTING BY ELECTRICITY is contemplated by the managers of the Manhattan Elevated Ry., and estimates have been asked on 216 separate electric lighting outfits, or enough to equip nearly the whole number of trains in service. The *Electrical Engineer*, in a discussion of the matter, estimates that with 12 16 c. p. lamps per car, and provision for head lights, tail lights and cab lights, an engine and dynamo of 7 to 8 HP. will be required on each train. Our contemporary also suggests that as the stations need better light as well as the cars, it may be well to adopt some system in which the trains would take up their electric supply as they moved along the line.

A SEARCH-LIGHT FOR RAILWAY PURPOSES was tested on Nov. 1 by Mr. WHEELER, electrician of the New Jersey Central R. R. One Huntington light of 3,200 c. p. was mounted on the switch signal bridge 20 ft. above the track. As a result the bricks could be counted in a station building ⅛ mile away; when turned on the track the ties could be counted to the same station. Colors were plainly distinguished at ¼ mile distance. At 1,500 ft. it would enable an engineer to tell the position of switches. The reflector was shaped like those of locomotive headlights, silver-plated and highly burnished.

THE MOST SERIOUS ACCIDENT of the week occurred on Nov. 3, on a branch of the Delaware, Lackawanna & Western R. R. at Rock Cut, 4 miles south of Syracuse, N. Y. A coal train was standing on a siding to wait for the passing of an express train, which runs through without stopping at the rate of 40 miles per hour. Just as the express train came in sight the telegraph operator, who was sitting at the station, suddenly conceived the idea that the switch was set wrong, and he rushed out and turned it. Just as he realized his fatal mistake, the express dashed over the switch onto the side track and collided with the engine of the coal train. The engineers and firemen of both engines were killed, and several passengers and trainmen were injured. A serious accident from an unusual cause on the New York, Providence & Boston Ry. is fully described in another column.

A BRIDGE ACCIDENT on the International & Great Northern R. R. near New Braunfels, Tex., Nov. 5, by which two men were fatally injured, seems from the press accounts to have been a square fall. The train was a freight, and the first span went down with the engine and three cars.——On the Covington & Macon R. R. near Madison, Ga., on Nov. 1, a passenger coach at the rear of a mixed train left the track on a trestle and was precipitated 40 ft., injuring several passengers.——Near Bellaire, O., Nov. 3, six cars of a Baltimore & Ohio freight train, while passing over a temporary trestle which replaces a steel bridge washed out Oct. 13, were derailed and precipitated into the river.

THE JUSTIN DYNAMITE SHELL was again tried on Oct. 30 at Parryville. No dynamite was used, but the shell was filled with sand and capsules of wax; spermaceti, paraffine and camphor were placed in it. The former shells were made of cast steel, and found to be full of blow-holes, and these were charged with being the cause of the two previous failures, by igniting the dynamite by the heat of the powder gas. The shell used in the last experiment was forged steel, and was recovered unbroken. It was found that none of the capsules of the above-mentioned materials were melted, and Dr. JUSTIN believes that he has succeeded in preventing the entrance of the gas into the shell. He will in a few days test the merits of the new shell by firing dynamite.

ELECTRIC LIGHT FOR LIGHTSHIPS is now being considered by the United States Lighthouse Board. The new lightship at Sandy Hook will be so equipped if the proposed plan works satisfactorily. Experiments are now under way at the lighthouse station on Staten Island.

THE KRUPP CO., OF ESSEN, has issued a serial report on experimental gunnery, treating of howitzer practice, firing at high angles. The later experiments were made at Meppen with an 11.27-in. howitzer, 11.6 calibres long, and weighing about 11 tons. The gun, with its carriage, weighed 14 tons, and the bed on which it stood 45 tons. The projectiles used were armor-piercing shells of 512, 661 and 936 lbs., and steel armor-piercing shells of 661 lbs. The charges, from 40.7 lbs. of pebble powder to 57.3 lbs. of prismatic powder, "*C* 82." The horizontal armor deck target measured 52 × 15 ft., composed of four super-improved and riveted steel plates of a total thickness of 3½ ins., backed by iron ribs and wood, and firmly supported about 5 ft. above the ground. The first shots were fired with an elevation of 45, and were 661-lb. shells, with a 25-lb. charge of pebble powder, and range of 3,870 yds., or nearly 2¼ miles. The greatest longitudinal deviation was 95 ft. and the greatest lateral deviation was 27 ft. The shell passed clear through the target at the second shot, bending the supports and tearing 10 rivets. In the second trial an elevation of 65° was used, with the same projectile and 33.8 lbs. of pebble powder. In 16 shots the greatest longitudinal deviation was 105 ft. and lateral 88 ft. One hit was made, penetrating the target as before.

THE IRISH CHANNEL TUNNEL scheme is again being agitated, and a meeting was held at Belfast, Ireland, in October, at which Mr. BARTON, C. E., submitted a proposition for a tunnel 33 miles long, between Magee, Id., County Antrim, on the Irish side, and a point in Wigtonshire, on the Scotch side. The greatest depth to be 500 ft. below the sea level, and the steepest grade to be 1 in 7 (5.33 per cent.)

NICARAGUA CANAL advices of Oct. 15 say that work has been commenced on dredging out the bar to the harbor and the first level of the canal. Five of the dredges used at Panama and now at the Nicaragua Canal are in a condition to go to work. The railway is steadily approaching completion, but progress is necessarily tedious as it passes through swamp land and all material must come from the east end. The timber in the swamp is cut, formed into rude cribs, and then filled with sand brought from the Greytown end.

THE MAKING OF ARTIFICIAL FUEL GAS is deeply interesting Pittsburg manufacturers. Among the companies mentioned as preparing for this change in fuel is the Pennsylvania Tube Works. Messrs. Swindell & Bros., makers of regenerative gas furnaces for making artificial fuel gas by the Siemens Anderson process, have considerable work in hand on new plant for mills. They say they can manufacture gas cheaper than it can be piped from wells.

The Serve Boiler Tube.

[FROM OUR LONDON CORRESPONDENT.]

A very simple device, which seems likely to do much toward increasing the efficiency of multi-tube boilers, has lately been introduced by a French engineer, M. SERVE. The invention consists simply in adding to the ordinary boiler tube a number of interior longitudinal ribs, generally about eight to each tube. The arrangement will be at once understood by the accompanying sectional view. The primary object is of course to get additional heating surface. This end is undoubtedly attained, for it is well known that the greatest resistance to the transmission of heat through metal is at the surfaces. Another advantage of these ribs is that they project into the interior of the column of heated gases and products of combustion flowing through the tube. This interior portion, or core of the column is always hotter than the sides. The gases have their temperature lowered by contact with the heating surface of the tube—which is naturally cooling surface for the gases—and it would seem that the colder particles have a tendency to stop on the outside of the column, so that much heat is carried to the smoke box which might more profitably have been absorbed by the metal of the tubes. There is a very good theory which accounts for this tendency of the colder gases to keep to the outside of the column. We need not stop to examine it now, but will proceed to give a few facts instead.

The manufacture of the Serve tube has been taken up in England by John Brown & Co., Limited, one of the great historic firms of Sheffield steel makers, in fact, one might almost say *the* great historic firm, for it was the ancient house of Brown that was the first among the big Sheffield steel makers to take up the manufacture of Bessemer steel. This firm, having, as they said, satisfied themselves as to the advantages of the Serve tube, determined to make a series of trials in order to prove to the engineering world at large that there is a benefit to be gained by the system. A number of engineers connected with the British and foreign governments, and others not holding official positions, were invited to attend the tests, and as I had also received an invitation to be present I am enabled to give some particulars of what took place. The arrangements for these trials were very complete, two large return tube boilers 10 ft. 6 ins. in diameter having been erected in the works. The following are the leading details of construction of these boilers:

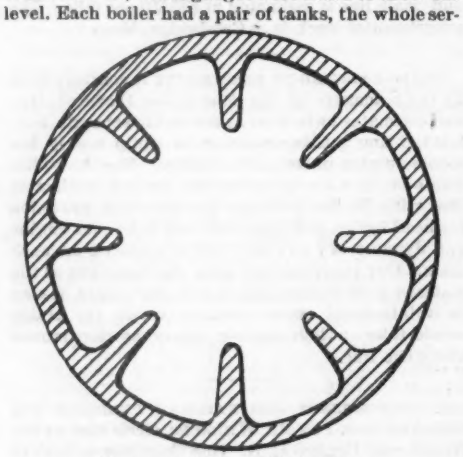
	No. 1. Serve tubes.	No. 2. Plain tubes.
Diameter of boilers	10 ft. 6 ins.	10 ft. 6 ins.
Length of boilers	10 " 6 "	10 " 6 "
Inside diameter of furnaces (two in each boiler)	2 ft. 10⅛ ins.	2 ft. 10⅛ ins.
Total number of tubes (steel)	126	126
Outside diameter of all tubes	3¼ ins.	3¼ ins.
Thickness of ordinary tubes	⅛ in.	⅛ in.
Number of stay tubes (steel)	34	34
Thickness of stay tubes	⅛ in.	¼ in.
Length of furnaces of all tubes	7 ft. 6⅛ ins.	7 ft. 6⅛ ins.
Heating surface of each ordinary tube	10.42 sq. ft.	5.95 sq. ft.
Heating surface of each stay tube	10.42 " "	5.45 " "
Total heating surface of tubes	1,312.9 " "	732.7 " "
Area of grate surface	31 " "	31 " "
Heating surface of furnaces	135.5 " "	135.5 " "
Heating surface of combustion chamber	88 " "	88 " "
Total heating surface of boilers	1,536.4 " "	956.2 " "
Proportion of grate to heating surface	1 in 49.56	1 in 30.84
Total tube area for passage of gases	802.36 sq. ins.	852.18 sq. ins.
Section of fire bars	1 in. sq.	1 in. sq.
Distance between fire bars	½ in.	½ in.
Funnel, rectangular section	4 ft. × 2 ft.	4 ft. × 2 ft.
Height of funnel from top of combustion chamber	43 ft. 7 ins.	43 ft. 7 ins.

It will be seen by the above details that the boilers are similar in all respects except in the matter of tubes; and it was with this intention that they were made. The greater total of heating surface in the tubes is naturally due to the ribs, which are calculated as efficient for heating surface. It will be noticed that the stay tubes in No. 1 (Serve) boiler are of thinner metal than in No. 2 boiler. This is admissible, as the ribs give the necessary longitudinal strength for the purpose, a fact somewhat in favor of the taking up of heat by the water. Another point of difference between the boilers—and this is one unfavorable to No. 1—is the smaller area for the passage of the products of combustion between the combustion chamber and the uptake. The effect of this will be noticed when we come to the details of the tests.

The first trial was made on Tuesday, Oct. 21, commencing at 10 A. M. Nixon's Navigation—the best (Welsh) steam coal that Britain produces—was used throughout. The object of these tests was to show the superiority of the Serve tubes over plain tubes, both with forced draught and with natural draught.

I have used the term "forced" draught, but this I fear is a heresy, for "forced" draught is in evil repute with the general public ever since a certain gallant admiral styled it "an invention of the Evil One." Therefore "induced accelerated draught" was used in these tests; a fan being placed in each chimney. The water gauge fitted to the uptake immediately below the fans would show the amount of exhaustion, or vacuum, and this would naturally be a factor in the measurement of the quantity of air supplied to the furnace. The system of forcing draught by a fan in the chimney is by no means new. It was tried years ago in H. M. torpedo vessel *Vesuvius*, and failed. The failure, however, was due to defects in detail, which have been avoided in the present instance; but I fail to see why "induced accelerated draught" should be greatly superior to forced draught, excepting in convenience of application.

The water fed to the boilers was measured by means of four tanks. These were accurately made to give a like amount of water for similar degrees of fall in level; water gauges were fitted to show the level. Each boiler had a pair of tanks, the whole service being separate, so that there should be no question about "accidental" admission to the wrong boiler, as there so often is with the three-way cock system. Smoke box temperatures were taken with an azotic gas pyrometer; but I look on the readings obtained by this instrument as so questionable that I shall omit to give them.



Section of the Serve Boiler Tube.

The following is the observed data:

Three hours trial with induced accelerated draught at a pressure of 1⅛ ins. of water above that of the smoke box.

	Boiler No. 1. Serve tubes.	Boiler No. 2. Plain tubes.
Total coal burned	3,808 lbs.	4,144 lbs.
Water evaporated	32,500 lbs.	31,000 lbs.
Lbs. water per lb. coal.	8.53	7.48

Three hours with natural draught in both boilers.

	Boiler No. 1.	Boiler No. 2.
Total coal burned	1,810 lbs.	2,2f0 lbs.
Water evaporated	18,200 lbs.	20,100 lbs.
Lbs. water per lb. coal	10.05	9.00

It should be stated that the tanks were gauged to give gallons to the inch, but I have transferred the gallons into pound weight, as more in accordance with engineers' practice. This may, however, give the figures a roundness they would not otherwise possess, but the errors cannot be more than 10 lbs. in any one case. It was intended to generate steam at atmospheric pressure and to effect this the loads were taken off the safety valves. The opening, however, was insufficient, and a pressure of 10 lbs. and more was shown on the steam gauges. It is not likely, however, that this materially affected the results as a comparative test of the two boilers. The feed water was taken from the ordinary town supply and pumped in at normal temperature.

It will be seen that on the trial the first Serve tube shows a very decided and altogether remarkable superiority. The fuel economy is 14.07 per cent., due simply to the ribbed tubes.

There is, however, some price to pay for this. With the lessened area for passage of gases, additional draught is necessary to afford a given rate of combustion, and it might be that air enough would not not be supplied for economical working with natural draught. If so, the cost of fan and fan engine, steam and working expenses for the same should be taken into consideration. The additional cost of the Serve tube over the ordinary plain tube should also be borne in mind. It can hardly be supposed, however, that those items would balance so substantial a gain as 14 per cent.

Consider next the natural draught trials, which will serve partially to answer the first point just raised. I may state in passing that a three hours' trial is not nearly long enough to be conclusive; but having watched these trials through the greater part of their duration, I consider them sufficient to afford at least a very fair guide.

Here we have a gain of 11.6% in water evaporated per pound of coal without the adventitious aid of "induced accelerated draught." The steam user can, therefore, according to these figures, save about 12% of his coal bill if he use Nixon's Navigation coal and does not want to run more than three hours. This brings us to another feature of the system. Cleaning tubes is an important point in all boilers, but it becomes additionally important when a smoky or bituminous coal is used. The ribs in the tubes will certainly not tend toward facility in sweeping, but it is a difficulty that may easily be exaggerated. The ribs, after all, are radial to the axis and the wires of tube brushes also radiate from the same center. There would be no difficulty in removing dust and ash, but a bituminous coal burned with insufficient air or with too small a furnace and combustion chamber would doubtless leave a "fur" on the sides of the leaves or ribs that would be more difficult to remove than it would from the interior of a smooth tube. The obvious reply to this is that no one ought to burn any kind of coal, and especially bituminous coal, in small furnaces or without enough air, both for his own pocket's sake and the comfort of his neighbors.

On the second day of the experiments there was a 12 hours' trial with the two boilers with "induced accelerated draught" again, the excess of pressure of the atmosphere over that of the smoke box being from 1 to 1½ ins. The test was so arranged as to burn exactly the same quantity of coal in both boilers in the 12 hours and the fans had to be manipulated in order to keep the consumption equal and so get through the given quantity by the time stated. As this is an important trial we will give the record in full:

BOILER NO. 1 (SERVE TUBES).

Hours.	Coal burned. Lbs.	Water evaporated. Lbs.	Vacuum at base of chimney. Ins.	Steam pressure. Lbs.	Temperature of feed. Degs.
1	1,568	9,000	1¼	16½	59
2	2,800	19,300	1	12⅛	66
3	3,808	27,000	1¼	15	60
4	4,928	39,800	1¾	11	61
5	5,824	49,600	1	10	60
6	6,832	59,300	1¼	11	60
7	7,504	68,600	1¾	10	60
8	8,400	77,200	1¾	10	60
9	9,520	87,300	1¾	11¾	60
10	10,416	96,000	1¾	10½	60
11	11,200	105,800	1¾	10½	60
12	11,872	114,600	1	10	60

BOILER NO. 2 (PLAIN TUBES).

Hours.	Coal burned. Lbs.	Water evaporated. Lbs.	Vacuum at base of chimney. Ins.	Steam pressure. Lbs.	Temperature of feed. Degs.
1	1,568	7,800	1⅛	9½	59
2	2,800	16,200	1⅛	8½	61
3	3,808	25,300	1¼	9	61
4	4,928	34,400	1¼	6	60
5	5,824	43,000	1¼	6	61
6	6,832	52,300	1⅛	10	60
7	7,504	61,500	1⅛	6¼	61
8	8,400	69,300	1¼	6¾	60
9	9,520	78,500	1¾	8	60
10	10,416	87,500	1	6¾	60
11	11,200	95,100	1⅛	4½	61
12	11,872	103,000	1⅛	6¾	60

The equivalent evaporation from and at 212° would be about 11.19 lbs. of water per lb. of fuel and 10.05 lbs. of water per lb. of fuel for the two boilers respectively.

It was intended in this trial to evaporate at 212°, but although the safety valves were taken off, leaving two 3¼-in. openings, the steam could not escape without pressure accumulating.

It will be seen here that about 11¼% more water was evaporated by the boiler with the Serve tubes; a considerable falling off from the short run of the previous day with "induced accelerated draught."

(Why not call it "coaxed," or "encouraged draught' if "forced" is objectionable? "Induced accelerated" is too long). Even 11¼% is, however, a very remarkable saving—really an enormous saving in the present day, when we are apt to imagine we have almost arrived at finality in these matters, and are content to advance by ones and twos or even halves and quarters per cent.

I have little doubt as to the accuracy of the records. Engineers will understand that an individual visitor is unable to personally vouch for the details of boiler trials, even when made under his eyes with every facility afforded for observation. The wealth, position and high standing of the firm of John Brown & Co. are, however, a substantial guarantee that the tests were made with all fairness, and there were too many experienced observers present for any very big mistake to be made. The French Admiralty has made experiments of a very similar nature. A copy of the official report is now before me, but without going further into details, it is sufficient to say that the results above quoted are more than borne out.

Other trials were made at Sheffield, but at the time of writing the records have not been reduced to shape. Observation does not lead to the supposition that the details above given are not generally borne out. Should it prove otherwise, note will be taken of the fact in a future issue.

I have given a good deal of space to the record of a very simple invention, chiefly on account of the remarkable results obtained, but largely also from the fact that it is so simple. Practical engineers do not require to be told that simplicity is a cardinal virtue in all engineering practice. The Serve tube is so simple that one wonders it has not been introduced before, but we must remember that it is only the advance in metallurgy that has given us a cheap material, capable of producing these tubes at a cheap rate. The ribbed strips, or skelps, from which they are made could hardly be rolled in iron.

The Proposed Public Administration of the Water Supply of London.

The water supply of London is at present in the hands of a number of water companies, serving different districts of the city and suburbs. It is now proposed that the city authorities shall acquire the companies' property, and it is probable that a bill will be introduced into Parliament at its next session by which the necessary powers will be conferred on the authorities. The question is a very complex one, and there will be considerable trouble over the amounts to be paid for purchase. Some of the suburban districts, while approving of the proposal to bring the water supply under one public authority, protest against that authority being the London County Council alone.

The Corporation Committee for County Purposes have presented a report on this question, in which they state that they are of opinion that the legislation which will deal with the supply of water to the 5,500,000 inhabitants of the metropolitan area should be comprehensive and final. They feel that any attempt at piecemeal legislation would involve as much parliamentary trouble and opposition and consequent expense as the settlement of the whole question of supply. Sir WM. G. HUNTER, M. P., an expert on the water supply question, was president of the committee. The inquiry was commenced in May, and meetings were held in London, Manchester and Glasgow. The general conclusion of the committee is that the supply of water to the public should be in the hands of a public authority and no longer remain as at present under the control of private companies. This is the same conclusion as that arrived at by Sir WM. HARCOURT'S Select Committee on London Water Supply in 1880, which reported that it was expedient that the supply of water to the metropolis should be placed under the control of some public body, which should represent the interests and command the confidence of the water consumers, and that a water authority of a representative character should be constituted with the necessary statutory powers.

The following abstract of the report presented in October last by the Committee for County Purposes is taken from the London *Daily Telegraph*:

Visits were paid to Manchester and to Glasgow, in each of which cities a public water authority prevails, and careful inquiry was made and evidence taken as to the working of the system. It is stated that in both cities the officials examined gave evidence showing the advantages and conveniences that had accrued to the consumers and to the cities themselves from the supply being in the hands of a public authority. As regards Glasgow, the comparison between its position when it emancipated itself from the private water companies and the present actual position of the metropolis is especially considered. Glasgow, up to 1855, was supplied with water by two companies (reduced by previous amalgamation from three), and in that year an act was passed authorizing their purchase by the magistrates of the city. The burden then placed upon the municipality appears to have been of a character both unexpected and oppressive. The works of the larger company were not usable, and had to be abandoned, an exceedingly large proportion of the purchase money being thus practically thrown away; but, with all this, the financial success has been thorough, and the comparative table of the quantity of water supplied and the prices charged in Glasgow and London respectively are in both instances largely in favor of the Scottish water consumer, who has supplied to his family considerably more water per head both for domestic and all other purposes, and (especially in the case of smaller tenements) pays considerably less for it. Evidence in this matter has been given by Sir ROBERT RAWLINSON, Maj.-Gen. SCOTT, and Mr. JAMES MORRIS GALE, the engineer of the Glasgow water-works. The average daily supply per head in Glasgow for domestic and all other purposes is 49.84 galls., while in London it is 29.91 galls. per head. The cost in Glasgow for a house of the annual value of $250 is, within the municipality, £1 9s. 2d. (about $7.25), and without the municipality, £2 1s. 8d. (about $10.41). These are the full amounts exacted, there being no extras in the shape of charges for bathrooms and other items, as is the case with every one of the London water companies. Comparing the metropolitan rates with the above, for a house of similar size in Lambeth (which it is only fair to state is from 40 to 75% dearer than any other metropolitan company) the water rate is £3 17s. about $19.18 more than two and a half times as much as in the city of Glasgow—and this, be it remembered, for a much inferior supply. On the same basis the Chelsea, Grand Junction, New River, and West Middlesex companies charge £2 4s. ($10.96), while Kent figures at £2 10s. ($12.50) and the East London and Southwark & Vauxhall companies at £2 14s. ($13.46).

Confirmed by such returns, and much kindred testimony, the Corporation Committee for County Purposes recommend that Parliament should be moved by the Corporation itself (for it is stated that at the present time no other public body has the power to incur the necessary expenditure) to legislate for "a representation of the areas, as the most effectual way of governing the watershed and managing the supply." They suggest the principle of arbitration as the fairest and best solution of the question of payment to the companies for their undertakings, and they claim to have it in evidence that the necessary moneys for the purpose of such acquisitions could be raised by the public water authority after its creation without any difficulty whatever. A sum of about $167,500,000 is hinted at as not an impossible one to be required for the purpose, and in his evidence Mr. SCOTT, the City Chamberlain, a financier of no small experience and sagacity, considers that no difficulty would arise in "placing" the stock on the best terms available on the day of issue, and not exceeding 3%.

On the somewhat delicate point of representation on the authority to be created, the committee take a large and liberal view; they think it should comprehend all the various municipal corporations, County Council, and sanitary authorities over whose areas the water authority would have control; that the city, considering the large proportion of its payments, should be adequately represented, and that the position of the London County Council should be "freely acknowledged and provided for." Suggestion is made that due compensation should be provided for directors and others retiring, and this being so it is not easy to see the reason that leads the committee further to recommend that a number of the directors of the bought-up and, therefore, defunct companies should be included in the new authority. Lastly, it is especially emphasized that the quinquennial assessment makes it imperatively necessary in the interests of consumers that some solution of the question should be arrived at in the next session of Parliament.

The Hall Process of Aluminum Production.

In our issues of Feb. 22 and March 1, 1890, was published the valuable paper by Messrs. A. E. HUNT, J. W. LANGLEY and CHAS. M. HALL on the properties of aluminum, and in that article a general description was given of the process of producing the metal in use by the Pittsburg Reduction Co. Since that time the company has greatly enlarged its plant, and its daily production of aluminum is now about 375 lbs. So much interest is felt in this metal, which promises to become of such importance in the arts, that we repeat the description of the process, with the accompanying cut, for which we are indebted to the *American Manufacturer*, showing the reducing pots in which the aluminum is extracted from the ore.

The crude material from which aluminum is at present obtained is bauxite, a hydrated oxide of alumina and iron. The mineral derives its name from being originally found in the vicinity of Baux, France. The bauxite at present used is imported from Germany, and costs about 5 cts. per lb. delivered at Pittsburg. This includes an import duty of $12.50 per ton besides the freight. Large deposits of the mineral exist in North Carolina and Georgia, and it is also found in vast quantities in Ireland and in northern France. Bauxite contains 55% to 58% of alumina, 10% to 14% of water, and 24% to 28% of silica and ferric oxide. As manufactured at Goldschmeidn, near Breslau, in Silesia, for the Pittsburg Reduction Co., the bauxite is fused with carbonate of soda in a reverberatory furnace. The fused mass is lixiviated with water, which dissolves the aluminate of soda, and this is decanted off. This solution is decomposed by carbonic acid gas, forming carbonate of soda, which remains in solution; and the alumina hydrate is precipitated as a white powder, containing about 54% of aluminum, in which form it is exported.

How hopeless would be attempts to treat bauxite by the ordinary methods of the furnace may be seen from the fact that it is so refractory that crucibles made from it remain unaffected when those of ordinary fire-clay lose shape and become partially fused.

The next process is the calcining of the alumina hydrate at a red heat, which drives off the water and leaves the alumina still in the form of a white powder ready for charging to the reducing pots.

As is well known, the metal is obtained from the alumina by the process of electrolysis, the alumina being held in solution in a molten bath composed of various fluoride salts, which conducts the electric current, but is not decomposed by it. The reducing pots in which the process is carried on are open rectangular boxes of wrought iron about 4 ft. long, lined with carbon inside, a small depression to admit the dipping ladle being left at the bottom of each. The negative conductor from the dynamo is electrically connected to the iron shell of the pot. The positive conductor is connected to a wrought iron frame placed just over the pot and supporting a number of carbon electrodes about 2 ins. in diameter. These are attached to copper rods, as seen in the drawing, which are held by clips, so that the carbon may be lowered into the bath as its lower end is gradually burned away by the oxygen of the alumina. About one pound of carbon is consumed per pound of aluminum produced. The pure aluminum as it is released from combination by the electric current falls to the bottom of the pot, being heavier than the fluoride bath, and is ladled out from time to time and cast into ingots, the molds for which are seen on the floor near the reducing pots.

The process goes on continuously, more alumina being thrown in the pot from time to time, new carbons taking the place of old ones as they are consumed, and the silvery, molten metal being ladled out at intervals when a considerable amount has collected. The heat radiated from the bath is quite moderate, and only when the workman ladles out the molten metal does he put on his mask, a curious looking rectangular shield which protects his face and eyes from the heat.

The cost of the materials for the fluoride bath is very small, and the bath does not deteriorate by use. A small quantity, perhaps 5 lbs. per week, is added to each pot to make up for the slight loss which occurs in ladling out the molten aluminum. The carbons used are 3 ins. in diameter and are made of compressed gas carbon. They cost about 3 cents per lb., 1 lb. of carbon being used to produce 1 lb. of aluminum. The ingots as cast from the reducing pots are remelted two or three times to purify them and secure a smooth solid ingot, fit for rolling. The slab, when ready for market is 6 ins. × 12 ins. × ¾ in. in size and contains above 98.52 % of metallic aluminum, the remainder being chiefly combined silicon.

The only part of the aluminum-producing plant which is especially expensive is that which generates the electricity required to decompose the aluminum oxide. The total energy required to dissociate one pound of alumina into its elements is given as equal to 35,640,000 ft. lbs. or 18 HP. acting for one hour. This, then, is the theoretical limit of economy

in producing aluminum by electrolysis. The Pittsburg Reduction Company are now producing about 375 lbs. of aluminum per day of 24 hours, with an expenditure of energy of about 500 indicated HP. Remembering the necessary losses between the steam in the cylinder and the electrical current delivered from the dynamo, it appears that the Company is now obtaining a pound of aluminum with the expenditure of less than 23 HP. of electric energy. Taking also into consideration the heat required to keep the fluoride bath fused with that lost by radiation and in the molten aluminum, and it is evident that the works are making a very commendable approach to the maximum possible economy in the use of power.

PRODUCING PLANT OF THE PITTSBURG REDUCTION CO.

The plant first erected by the company had a capacity of but 50 lbs. of aluminum per day. Power was furnished by a 125-HP. Westinghouse engine driving two 1,000-ampere 25-volt Westinghouse dynamos. The dynamos were run in parallel and supplied current to two reducing pots in series, each of which required 10 volts. The additional plant put in operation in the spring of the present year consists of two 200-HP. Westinghouse compound engines, additional boiler capacity of 624 HP., and two dynamos, specially designed for the company by the United States Electric Light Co., each furnishing a current of 2,500 amperes and 50 volts. These dynamos operate 5 reducing pots connected in series. The boilers are all fired by natural gas and are of sufficient capacity to permit of part of the plant being held in reserve. Each of the compound engines is belted direct to one of the large dynamos, and the 5,000-ampere current from the two is carried to the reducing pots by two copper bars, each having a cross-section of 3 sq. ins. The 2,000-ampere current from the two small dynamos is carried to the reducing pots by a copper bar of 2 sq. ins. cross-section.

Over the engines and dynamos is a 6-ton traveling crane for use in removing armatures or making repairs; the necessity for this is apparent when it is remembered that each of the larger dynamos weighs 24 tons. The labor required in operating the plant is quite small. An engineer and one assistant look after engines, dynamos and boilers; one or two men are in charge of the reducing pots, one is engaged in remelting, and there are one or two laborers. With an enlarged plant the cost of labor per pound of product will be considerably decreased. So large is the present demand for aluminum and so promising are the prospects of a large increase in the demand in the near future, that plans have already been completed for a plant which will produce 5 tons of aluminum per day, requiring for that purpose about 13,000 HP. Of course the best point to establish such a plant will be where power can be obtained most cheaply, and by choosing a site either where ample water power can be had or near the mouth of some coal mine it is expected to largely reduce the present cost of manufacture.

A plant has just been put in operation at Patricroft, near Manchester, England, to make aluminum under the Pittsburg Reduction Company's patents, which it is expected will go far toward supplying the foreign demand, for the present at least.

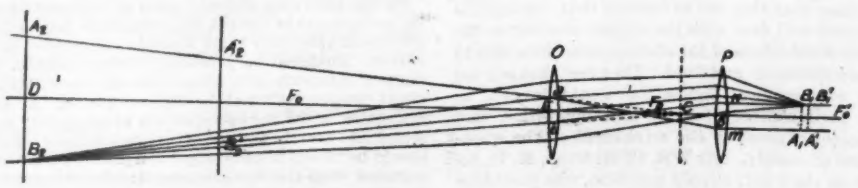
Among recent discoveries in connection with the application of aluminum in the arts is the fact that a tempered pure aluminum can be produced which will take a cutting edge and is considerably stronger, harder and more elastic than the untempered article. Processes of plating with aluminum are also being perfected, both by use of the electric current and by dipping as in galvanizing. It is claimed further that in making nickel steel, which has recently been brought into such notoriety, the addition of a small amount of aluminum increases the homogeneity of the alloy.

In another column some estimates will be found concerning the probable cost of producing aluminum by this process when the maximum possible economies shall have been effected.

The Porro Telescope for Stadia Work.

By J. B. Johnson, Prof. Civ. Eng., Washington University, St. Louis.

The objection which is most frequently urged against the use of the stadia method by those who are familiar with its theoretical principles only is that the distances read on the rod are not the true distances from the center of the instrument, but from a point in front of the objective equal to its focal length. It is true the rod may be so graduated as to give the true distance from the center of the instrument for any particular length of sight, but for other distances the reading is either too large or too small by an amount less than 1.5 feet in the most extreme cases.



Although these objections are of little force in practice, since such small distances do not show on the plat, still it is very desirable to avoid such errors, for one's mental satisfaction, if for nothing else. If these errors could be avoided it is probable that many engineers and surveyers would use the stadia who now refuse to resort to it even in rough work.

It is not generally known that this error may be avoided by changing the construction of the telescope, but such is the fact.

In 1823 Mr. Porro, a Piedmontese officer, and afterwards a professor at Milan, invented a telescope which accomplishes this result, and in such a way as not to interfere with its use for all other purposes in transit work. It is done by the aid of an auxiliary lens placed back of the objective, which latter is now of a lower refracting power.

In the figure, let the lines $A_2\ a\ C$ and $B_2\ b\ C$ be the lines which limit the measuring angle and which meet at C, the center of the instrument. That is to say, these lines are such that a pencil of rays starting from any point on the line $A_2\ a$ is brought to a focus upon the cross-wire at A_1, and any pencil of rays starting from a point on the line $B_2\ b$ is brought to a focus on the cross-wire B_1, these lines $A_2\ a$ and $B_2\ b$ meeting, if extended straight through the objective O, at the center of the instrument, C. But in passing through the objective these rays are refracted so as to meet at some point as F_p, and if this point is also made the principal focal point of the auxiliary lens P, then those particular rays pass out of the lens P on the *parallel* lines $m\ A_1$ and $n\ B_1$.

For a rod placed at $A_2\ B_2$ the image is formed at $A_1\ B_1$, the image of A_2 being at A_1, and of B_2 at B_1. If now the rod be moved to the position $A'_2\ B'_2$, the image will move to $A'_1\ B'_1$; but since the rays entering the objective along the lines $A_2\ a$ and $B_2\ b$ emerge from the auxiliary lens along the *parallel* lines $m\ A_1$ and $n\ B_1$, it follows that the *images* of any two corresponding points on the lines $A_2\ a$ and $B_2\ b$ remain at a *constant distance apart*, and, therefore, if cross-wires be placed at these points the refocusing for varying distances does not prevent the wires from measuring an interval which *varies directly with its distance from the center of the instrument.*

It will be seen that the points Fp and C are conjugate foci on the same side of the lens O, the distance $E\ C$ being the distance from the center of objective to center of instrument commonly denoted by C. The principal focus of O in front is at some point as Fo, and the principal focus of P is at Fp.

Then we may have:

Focal length of O, $F_o\ E = f$.
" " " P, $F_p\ G = f'$.

The conjugate focal distances, $\begin{cases} E\ F_p = f_1. \\ E\ C = (-c). \end{cases}$

The distance $D\ C = D$.

Then for the lens O we have, from the general equation of conjugate focal distances:

$$\frac{1}{f_1} + \frac{1}{(-c)} = \frac{1}{f} \quad \text{or} \quad f_1 = \frac{f\,c}{f+c} \qquad (2)$$

and

$$\frac{f_1}{c} = \frac{f}{f+c} \qquad (3)$$

Now let the angle $a\ C\ b = C$ and the angle $a\ F\ b = F$, and since these are very small we may suppose them proportional to their tangents, whence

$$\text{Ang. } F : \text{ang. } C :: c : f_1 :: f + c : f,$$

$$\text{or ang. } F = \frac{f+c}{f} \text{ ang. } C \qquad (4)$$

$$\text{But tan. } C = \frac{A_2\ B_2}{D} \text{ and tan. } F = \frac{m\ n}{F_p\ G} = \frac{A_1\ B_1}{f'}$$

therefore we have

$$\frac{A_1\ B_1}{f'} = \frac{f+c}{f} \cdot \frac{A_2\ B_2}{D}, \text{ or}$$

$$A_1\ B_1 = f' \left(\frac{f+c}{f}\right) \frac{A_2\ B_2}{D} \qquad (5)$$

This equation gives the distance between cross-wires for a given ratio of intercepted portion on rod to distance from the center of the instrument. If this ratio be taken as $\frac{1}{100}$, which is commonly chosen, then we have, for the distances between cross-wires:

$$A_1\ B_1 = \frac{f'}{f} \cdot \frac{f+c}{100} \qquad (6)$$

The distance f is the focal length of the objective, which may be obtained approximately by removing it from the telescope and obtaining an image of the sun. The distance $\frac{c}{R}$ is readily measured on the telescope, it being the distance from the vertica

axis of the instrument to the center of the objective.

The focal length of the auxiliary lens f' must also be found independently, as with the objective, but these lenses must be chosen with reference to the length of the telescope desired.

Thus the distance from the objective to the cross-wires is made up of the distance between the lenses O and P, which is $f_1 + f'$, and the distance between P and the cross-wires. This latter distance varies for different positions of the object, being $f - \frac{f'^2}{f^2}(f + c)$ for a stellar focus and f' for the object placed at the distance f in front of the objective.

Therefore, we have, for the distance between the objective and the cross-wires, for a stellar focus:

$$L = f_1 + 2f' - \frac{f'^2}{f^2}(f + c)$$
$$= \frac{fc}{f+c} + 2f' - \frac{f'^2}{f^2}(f + c) \qquad (7)$$

and for the nearest position of object, say 1 ft. in front of the objective,

$$L = \frac{fc}{f+c} + 2f' \qquad (8)$$

where

L = distance between objective and cross-wires.
f = focal length of objective.
f' = focal length of auxiliary lens.

If we make $f = 15$ in., $f' = 4$ in., and $c = 6$ in.,

then the extreme distance between objective and cross-wires, for an object about 1 ft. in front of the objective, is from (8), 12¼ in.. and the minimum distance, or the distance for a stellar focus, is from (7), 10¾ in.

If $f = 14$ in., $f' = 3\frac{1}{2}$ in., and $c = 6$ in.,

then the extreme distance between objective and cross-wires is 11.2 in., and the least distance is 10 in.

For this latter case, the auxiliary lens being placed $f_1 + f'$ back of the objective, we have from (2)

$$f_1 = \frac{fc}{f+c} = \frac{6 \times 14}{6 + 14} = 4.2 \text{ in.}$$

Whence the distance between these lenses is 4.2 + 3.5 = 7.7 in., or 1.7 in. back of the center of the instrument.

These two lenses, O and P, must remain at a fixed distance apart, and hence must be mounted in the same tube, and if the objective slides they must move together.

A very notable result of this combination are the small movements required in focusing on objects at varying distances, and the ability it gives one to read upon objects within about 1 ft. (the focal length of the objective) of the object glass. Thus the movement of the cross-wires (or objective), in the second case worked out, was only 1.2 ins. from a stellar focus up to a position of object 14 ins. in front of the objective. It would probably be a profitable venture for some of our best instrument makers to go to manufacturing these telescopes for their transit instruments. They should always be made to invert the image and so avoid the use of the two erecting lenses. In this way a better definition is obtained, and a lower refracting power can be used in the objective and auxiliary lenses for the same length of telescope.

THE PANAMA CANAL is actually a thing of the past, and nature in her works will soon obliterate all traces of French energy and money expended on the Isthmus. Reports of Oct. 25 say that the late heavy rains have caused vast slides into the canal from the hill tops near Obispo, and the canal excavation at Circaracha is entirely filled up. Only one dredge of the American Company now remains at Colon, the *Nathan Appleton*. The dredge *Ferdinand Lesseps*, of the same company, was sunk about 60 miles from Colon, while being towed to Greytown. Lieut. N. B. WYSE, acting for the Panama Company, writes from Bogota, under date of Oct. 20, that owing to the exacting terms sought to be imposed by the Senate Committee, "it appears that t will be impossible to reach an understanding."

Subaqueous Foundations.*

LECTURE I.—INSIDE WORKS.

During the last thirty years marked progress has been made in what may be termed the department of engineering science which deals with foundations of structures laid down under water. New methods of executing work, new appliances and new materials of construction have enabled the engineer to successfully execute works which, a comparatively short time ago, would have been either quite impossible, or prohibitory on account of cost.

In the two lectures I am about to deliver I will endeavor to place before you the most recent practice in subaqueous foundations, illustrated by representative examples of work executed. I will also refer to the ordinary methods of timber piling and coffer-dams, which are so valuable in numerous cases for works of moderate extent, or where exceptional difficulties do not present themselves.

In cases where a depth of only a few feet of water has to be excluded, no limitations imposed in regard to space occupied and the foundation composed of sandy or clayey material, then an earth dam formed entirely of clay, or having a central wall of clay, is the simplest and most effective method of excluding the water for the site of the works, and, as regards maintenance, is the least troublesome, care, of course, being exercised to see that a complete clearance be made along the site of the proposed dam of all stones, gravel, shingle, sand or other materials which would allow water to pass freely. In a semi porous stratum a trench should, if possible, be excavated or dredged down to an impervious stratum, or to such a depth that there would be no danger of percolation of water through the strata underneath the dam, which depth would be dependent on the nature of the strata, and the head of water against the dam. A very thin wall of puddled clay, say from 12 ins. to 18 ins. in thickness in the center of an earth embankment, is quite sufficient to serve as a water-tight wall, provided that care be taken that the clay is of good quality, free from stones or other extraneous substances, and has been thoroughly chopped and well worked before being placed in the dam, in successive layers, each layer being rammed or punned in place, so as to leave no horizontal lines or joints of separation. In practice, however, it is better to carry up a much thicker wall of clay, so as to provide a good margin of safety against the risks of defective workmanship, and the use of inferior materials. The places where leakages are most likely to occur in such dams, or, indeed, in dams of any kind, are their ends, or junctions, with smooth surfaces, such as the faces of quay walls, paved slopes, embankments, etc., and special precautions should be taken at such places by forming gusset dams, grooves, if possible, in the walls, or by increasing the thickness of the puddle clay, and also by exercising great care with the punning and hard stock ramming of the clay. I might quote a number of instances from my practice of the importance of such precautions, but one may suffice, which occurred at the eastern entrance of the James Watt Dock at Greenock. An earth dam was there formed to exclude a head of water of about 14 ft. At one end of the dam, which abutted against the paved slope of an embankment, sufficient care was not exercised by the contractor in making a proper junction of the dam with the paved slope; the result was a heavy leak, which undermined the paved slope, involved a heavy outlay to stop it, and also caused a serious delay in the general progress of the works. An earth dam, with its slopes, occupies a considerable area of ground, and is seldom used, except in cases where there is ample room. When the area for operations is limited, there may be used a single pile dam, backed up with clay on the outside, and walled and strutted on the inside.

In the construction of quay walls, where half-tide dams are sometimes employed, that is, dams constructed to such a level as to exclude the tidal waters, from half-ebb to half-flood, single pile dams are most serviceable. I have used them in a number of instances, the most recent being in the harbor of St. Helier, Jersey, last year in the execution of some harbor improvements there. In the southwest angle of the Victoria Harbor, St. Helier, a new landing stage was constructed, the quay, or front wall, of which was founded on the rock, at depths varying from 12 ft. to 22 ft. below the surface of the bottom of the harbor. The back, or light division walls, of about 25 ft. in height below coping, along the side of the inclined railway, down to the middle and lower landings, were founded on bearing piles from 24 ft. to 30 ft. in length, driven down to the rock, or to depths of from 47 ft. to 53 ft. below high-water level, and although the capsills, longitudinal and cross bearers, and bruised points of piles on the rock were subjected to this great weight of wall and filling, they have not squeezed down, or subsided more than at the rate of about 1-32d in. per foot in height from quay level to the rock, which is not nearly so much as usually takes place under similar conditions, while the face wall, which is founded on the rock, shows, as a matter of course, not the slightest sign of subsidence or movement of any kind for its whole length. By founding the division walls on bearers and bearing piles, instead of on the solid rock, a saving of several thousands of pounds was effected. To enable the front wall to be founded on the rock, I had a back and front row of 6-in. pitch pine close sheeting piles driven at about 16 ft. apart and parallel with the back and front faces of the proposed quay wall. These piles were driven to the rock, or as far down as 25-cwt. monkeys would drive them. The tops of these sheeting piles were cut off at a few feet below half-tide level, and clayey material was embanked against their outside faces. The material driven through was composed of fine compact sand and clay. The range of spring tides is nearly 40 ft. and the depth from high water to the rock in the bototm of the trenches was in some places as much as 53 ft. or 33 ft. below half tide. The rock for the full length of the wall foundations in the trench was successfully laid bare, and the wall founded thereon, at depths varying from 47 ft. to 53 ft. below high water of spring tides. The trench was cleared in lengths, equal in capacity to about 900 tons of water on an average, which took about 42 minutes to pump out by a 16-in centrifugal pump, mounted on a barge. At one end of the trench the new works abutted against an old quay wall of the Victoria pier, founded on loose stones and sand at about 12 ft. above the bottom of the new work, and the foundations of the old work had to be protected by pole boarding below the feet of the sheeting piles of the trench. Some trouble was here experienced, in several instances from "blows" through the fine sand at open joints in the sheeting piles, and under the piles, but the "blows" were promptly dealt with as they arose. Had prompt attention not been paid to these "blows" the dam would have soon collapsed, as the removal of the sand from the back of the dam would have so slackened everything as to have rendered the sheeting piles, struts, and walings free to float or rise up, as soon as the incoming tide had filled the dam.

Stock ramming, often found serviceable in tightening leaky coffer dams, was used at this work in filling up a large cavity under the wall, and also in stopping a heavy "blow" from under the foot of a broken pile which had not stood driving down to the rock. I may here give you a short description of what is known as stock ramming. During my practice I have frequently had to deal with most serious leaks, under and through coffer-dams, foundations, dock sills, dock sides, and dock bottoms. These leaks, subjected to constant heads of water, had they not been immediately dealt with, would in a very short time have brought about the entire failure of the works. In such cases any attempts to have stopped the leaks by grouting up with Portland cement would have been futile, for as soon as the grout poured down the pipes had reached the leaks it would have been washed away. Grouting up with Portland cement can only be done successfully when it is possible to equalize the head of water, so as to prevent any disturbance of the grout until it has thoroughly set, and is capable of resisting water pressure. Sometimes leaks are gauged, that is to say, only so much water escapes as can pass through the interstices of a bank of rubble, rough ballast, fissures, or open joints in masonry, or in sheeting piles, or through hollow beds between the underside of a foundation course of masonry and the surface of a rocky foundation. Such leaks are not immediately dangerous, for as soon as the puddled clay in the rear of these leaks is washed away the velocity of the leakage water, owing to the enlarged orifices in the puddled clay, is so reduced as to pass almost harmlessly away. But leaks which are not so gauged, that is to say, those which pass through the puddle and retain their full force due to a constant head of water, irrespective of the size of the orifices, and acting directly and freely on the puddle, soon create a great "blow," and effect a speedy destruction of the dam. For tightening up dams, dock bottoms, etc., I have used a stock-rammer as per sketch (Fig. 1). It is about 3 ins. in diameter, 3½ ft. in length, and has its head and foot rung with iron. A ¾-in. air-hole is bored up from its foot for about 20 ins. or 30 ins., and this is covered by a thick shoe-leather flap, which serves as a valve to admit air and prevent suction during withdrawal.

FIG. 1.

In stock-ramming a coffer dam, 3¼-in. holes are first bored in the piles, then charges of clay in rolls of about 3 ins. in diameter and of from 6 ins. to 9 ins. in length are inserted into them. The stock-rammer is then driven by heavy mauls into the hole as far as its length will admit is afterwards withdrawn and other charges of clay inserted, and so the process is repeated until it is found impossible to drive in more clay. The action is similar to that of a Bramah press, and by this means heavy leak

* By Walter Robert Kinipple, M. Inst., C. E. Lecture delivered before the Royal Engineers' Institute at Chatham. From the London *Engineering*.

in dams have been readily and successfully stopped in a very short time. A coffer-dam across the entrance channel-way to the graving dock at Greenock, erected in the year 1871, was so badly filled with inferior puddled clay that, on testing it, it leaked to such an extent as to threaten its destruction within a few days. Stock-ramming, as above mentioned, was resorted to, and in a week or so it was rendered absolutely water-tight, although there was a head of water against it of about 15 ft. each tide during the process of stock-ramming and tightening up. A wooden plug was inserted in each hole, and was removed from time to time as further clay was found necessary. In earth or puddled clay dams of great width at base, across valleys, it is necessary for stock-ramming purposes to put down bore-holes as near as possible to the sites of the leaks and of from 3 ins. to 5 ins. in diameter, and line the same with wrought-iron tubing. Charges of well-puddled stiff clay are then dropped into the pipes, and rammers of wrought-iron round bars nearly filling the pipe, and having air-holes and flap as in the smaller rammer, are lifted up by a small pile-driving engine, worked by steam or hand, and dropped from a height of 10 ft. to 15 ft. down the tube, as the case may require. In this manner the puddle clay can be inserted and rammed hard into any of the cavities or leaks in the bore-hole, and

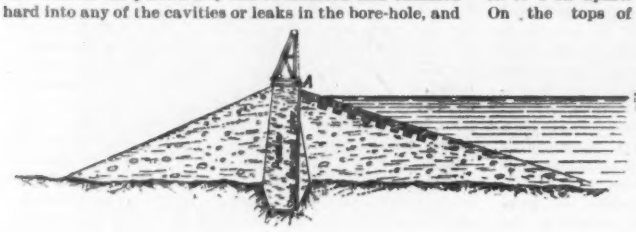


FIG. 2.

the softened and wasting clay may be hardened and tightened up to such an extent as to effectually and securely stop any leak in the dam. In fact, hard ramming may be carried on to such an extent as to almost lift a dam of 100 ft. in height. The positions of the bore-holes for stock-ramming such dams would depend upon the section and construction of the work, but generally the most suitable positions would be as shown in Fig. 2.

Single pile dams may be utilized for excluding a very considerable head of water, if sufficient care be exercised in so driving the piles as to insure close joints, and additional precaution be taken of grooving the piles and inserting iron or hard wood tongues. Very successful and well executed work of this class was done in connection with the founding, at 47¼ ft. below T. H. W., the four piers and two abutments of the new Putney Bridge over the Thames. The piles were 14 ins. square, having elm tongues, and were driven through mud and clay down to the stiff hard clay, and formed almost perfectly water-tight dams. After the dams were completed, the pier foundation caissons were sunk inside the dams to a lower level, and rapid progress was afterward made with the excavations and the founding and building of the piers within the dams. The use of a single pile dam, which occupies a minimum amount of space, is an important consideration, especially when the area is limited. It is essential, however, that very careful work should be done, especially where there is a great head of water against the dam. Where the conditions are such, either from the inexperience of workmen or from the nature of materials through which the piles have to be driven, that it is impossible to make close work, recourse should be had to a double pile dam inclosing a wall of puddled clay; such dams being used for heads of water up to 40 ft., and in sites where it is impracticable to obtain close jointed piling. The dimensions of the timbering and ironwork are, of course, dependent upon the head of water, and likewise on the conditions of each particular case. In a dam of about 500 ft. in length, which I designed for the Esquimalt Graving Dock Works, Victoria, British Columbia, there were three rows of close piling, the depth of water in the center of the dam being nearly 35 ft. at high water, gradually diminishing towards its ends. Along the site of the dam there was a layer of sand and shells, several feet in thickness, everlaying a bed of clay in the center portion of the dam and rock at each end of it. The sheeting or close piles of the dam were of 12-in. by 12-in. fir timber, the gauge piles 15-in. by 15-in., also of fir timber, as well as the wales, which were 12-in. by 12-in. The thickness of the puddle between the piles was 7 ft. At the ends where the dams rested on the rock, special precautions were taken by means of heavy rock shoes on the piles, and by depositing concrete along the feet of the piles to render the dam secure. The dam was thoroughly water-tight from its completion in October, 1879, until the spring of 1887, or just prior to the opening of the dock.

Wherever it is possible in the execution of the subaqueous portions of the works to exclude the water from the area of the works by such simple means as dams, and where there is no objection in regard to space occupied, then undoubtedly such a course should be adopted. The facilities for executing such temporary works are usually at hand, and above all it is most advantageous and economical to carry on the main works within an area laid dry, where work can be executed with rapidity and in the best possible manner, instead of under water, where, even when perfectly satisfactory results are believed to have been obtained, they are generally under disadvantageous conditions. There are many cases, however, where, owing to considerable depths of mud or soft strata, it would be quite impracticable to exclude the water by means of dams, and recourse must then be had to other methods of founding, such as sinking by means of caissons down to a firm stratum, or of driving bearing piles down to the same, or the foundations may be spread out so as to increase the bearing area (Fig. 3).

Founding on the tops of bearing piles is a very old practice. It is still used to a considerable extent, but not so much as formerly. The general practice is to drive over the area of the foundation piles from 9 ins. to 14 ins. square, and centered from 3 ft. to 4 ft. apart. On the tops of these piles whole timber bearers are laid longitudinally and transversely, and covered with planking, the whole being well bolted together, and the masonry structure built thereon. Timber, when thus completely buried, is preserved for a very long period. I have here a specimen taken from one of the bearing piles of the foundation of the old Stockwell Bridge, Glasgow, a structure built in the year 1345, by Bishop Rae, in the reign of King David, son of Robert the Bruce, taken down in the year 1850, and replaced by the present bridge. The oak timber in the piles and bearers when taken up was as sound as when first laid down. A quantity of the timber taken from these foundations has been converted into tables, cabinets, picture frames, etc., and no appearance of shrinking or drying up has been visible, which is remarkable after having been buried for so long a time. I might give another instance of the durability of timber where so buried. In 1860 the bottom of the King and Queen Dry Dock, Rotherhithe, was reconstructed, when it was found that the old dock bottom groundways of English elm, which were taken up, were in such a good state of preservation that I had some of the ribs of the new gates to the dock made from them. Dock walls almost innumerable exist founded on piles, especially in Holland, where they have been used to a very large extent. In founding on piles the piers of bridges crossing rivers, precautions must be taken to guard against the risk of any scouring action set up by tidal or other currents removing a portion of the bed of the river next to the piers, thus leaving the piles exposed for a portion of their height, and which, if not protected, would soon result in the failure of the bridge. Many subsidences of the piers of bridges have been brought about through this cause; for instance, the old Westminster and Blackfriars bridges across the Thames, and recently, to guard against such risks, the foundations of Waterloo Bridge have been protected and strengthened, ordinary coffer-dams having been used for excluding the water, so that the protection of works of underpinning and concreting around the bases of the piers could be executed dry. Precautions against scouring action may also be taken by surrounding the bases of the piers with concrete deposited *in situ*, or by rubble stones of sufficient sizes to resist the strongest currents, or by depositing the same in the form of rough rubble paving between the piers of the bridge, and for some distance above and below the cutwaters. The last-named method, however, is highly objectional in a navigable river, especially if there is only sufficient depth of water for large vessels to pass at the top of the tide. A better course to pursue is to carry the solid foundations down to a firm stratum, or to such depths that no danger need be apprehended from scour. In some instances, where great depths of soft strata exist, and where very long piles had to be used, it has been necessary to "fish" them, as shown in Fig. 4, in order to obtain the necessary length; thus, at the Prince's Pier, Greenock, a section of which is given in Fig. 5, there is a considerable depth of very soft strata, as much as 60 ft. in places, below the bed of the river, overlaying the firm clay. An ordinary masonry or concrete quay wall on such a site as this would have been almost impracticable, and a timber structure was therefore adopted, consisting of piles 16 ins. square driven down into the firm clay. Many of the piles were upward of 90 ft. in length, each formed of two logs fished and jointed together during the process of driving. So soft was the material overlying the hard clay that the piles by their own weight sank several feet into it before a blow was struck by the monkey. The upper portion of these piles were of greenheart timber from 40 ft. to 50 ft. in length, and their lower portions of pitch pine. In driving to such depths considerable difficulties were encountered, but these were gradually overcome as the men gained experience. The quay is 20 ft. in width at top, and the piles are spaced 10 ft. apart transversely and 8 ft. longitudinally. At about 2 ft. and 15 ft. down from the top of the piles heavy ties are secured to the back piles of the pier and carried back for a distance of 100 ft. to the back-tie piles, used for tying back the quay. The filling behind the quay was retained by sheeting piles and back planking. Subsidences of the backing of clay, which was the material first used for filling, took place to such an extent as not only to cause the piles to bend forward, as shown (Fig. 5), but the bed of the river in front of the quay to rise several feet. As the heavy material deposited behind the piles was gradually filled in, so the mud in front of the quay continued to rise higher and higher, when, owing to the heavy pressure caused by the backing of clay, the piles became so bulged at about 30 ft. down from cope as to subject the lower ties to such a heavy strain that they ultimately gave way; while the top ties, by the falling back of the heads of the piles became slackened. At this juncture, in January, 1869, I was consulted by the Greenock Harbor Trust, and the measures I then adopted to prevent further movement of the structure were to dredge a trench 24 ft. in width by 8 ft. in depth, and 1,000 ft. in length, along the front of the quay, below the bottom where the bed of the river was soft, and to fill it up with whinstone rubble, which had the effect of at once arresting the outward movement of the quay and of practically taking off the strain from the whole of the ties. This was so marked that it became quite an easy matter to straighten the line of quay by adopting a few further precautionary measures, such as backing up behind the quay with cinder ashes, depositing extra rubble under and in front of the quay, and also by utilizing the bumping of steamers against the quay at the places where it had bulged the most, the ties having been previously very tightly screwed up, and men told off to give an extra screw up just as the steamers bumped. Additional ties were carried back to nearly 250 ft. from the front of the quay, stone being deposited in front of the tie piles and cinder ashes behind them.

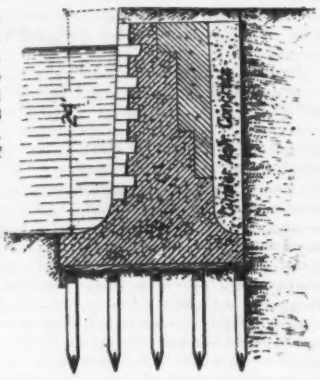


FIG. 3.

Fig. 4.

Since the introduction of Portland cement as a building material, it has been used to a considerable extent in the construction of subaqueous foundations. Many devices have been adopted to secure, by means of Portland cement concrete, substantial and reliable work under water, sometimes with the aid of divers and sometimes without, or almost so. In many instances the proportion of materials, and the manner of placing them in the work, have been such that sound work could not possibly be executed. Too frequently the fact has been overlooked that, owing to the particles of the cement being very fine, as compared with those of the sand gravel, and broken stone with which the cement is mixed, the slightest current of water disturbs the cement, and a very large portion of it is washed away, so that in one part there is an excess of cement, and in another less than there should be, or perhaps none at all. In addition to this, in opening the skip and discharging the concrete a still further displacement occurs. Precautions to a certain extent can be taken against cement being carried off by currents, but there is always a dissipation or loss of strength irrespective of loss by waste, and which has been determined by numerous experiments as being upon an average, as nearly as possible, equal to about one-half of its strength out of water, and, therefore if it be desired to construct subaqueous work equal in strength to 8 to 1 concrete work out of water, it is necessary to use materials in the proportions of at least 4 to 1. It is quite an easy matter for any one to test this, and it will be seen even under most favorable conditions, by filling into a box, out of water, say, ordinary 6 to 1 concrete and allowing it to set for three months, and by placing some of the same concrete in a similar sized box filled with water, and displacing the same by the deposit ing of the concrete in the box, that at the end of the three months the under-water work will be very much inferior to that of the out-of-water work, and most likely will be found to be not more than from one-half, or, perhaps, even one-third of the strength of the work done out of water. With due care, such as by the use of facing skips and very fine extra strong concrete, better results might be obtained in regard to the lessening of the separation of the materials used than by the use of ordinary skips; for by the latter the stones and other coarse materials roll out from the general mass and lodge in the corners and against the faces of the molds, and thus exceedingly defective work is obtained. Portland cement concrete in

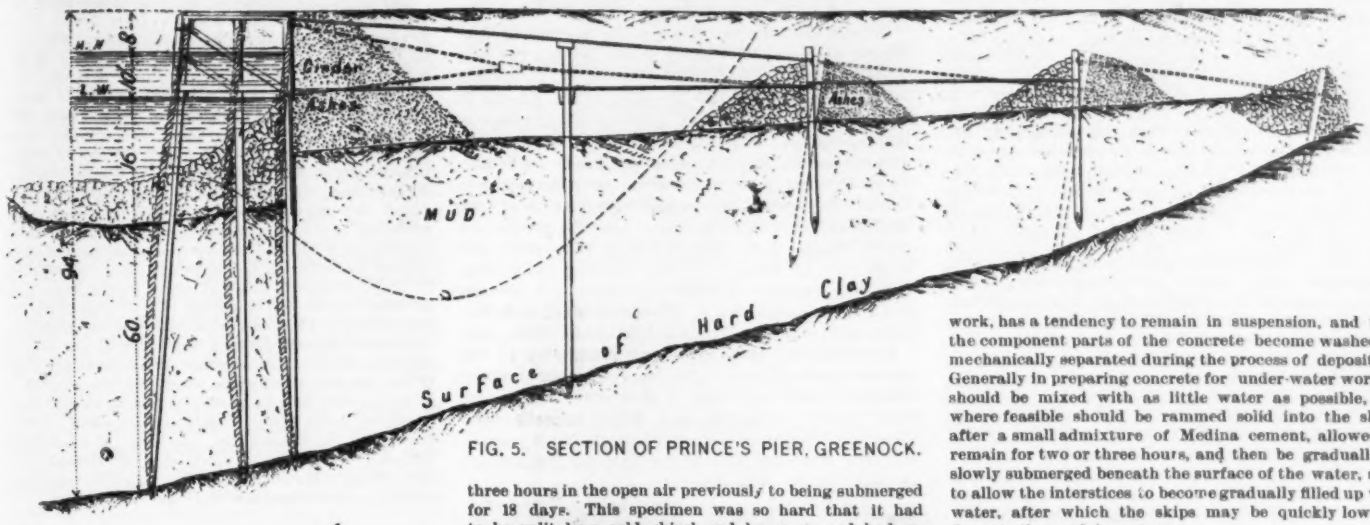


FIG. 5. SECTION OF PRINCE'S PIER, GREENOCK.

situ for work under water has occupied my attention for very many years, and with all the study and care which has been bestowed on it by engineers to insure sound work, and although in years past I have strongly advocated its use for monolithic work in subaqueous foundations, from the many indications in recent years that the life of such concrete is not likely to be that of centuries, I am almost led to the opinion that in the construction of all important sea works the use of rubble concrete blocks faced with masonry, and the finest quality of cement, selected from well-burned clinkers, used in the body of work, and for grouting up the bed and joints of the blocks, should supersede concrete *in situ*. I will describe what I mean in detail in my next lecture. In the years 1856 to 1858, when Portland cement was regarded as the newest material of the day for under-water work, I made a number of experiments with reference to this, the results of which I laid before the Institution of Civil Engineers in the year 1866.* I there stated that to obtain sound work without loss of cement it was absolutely necessary to keep the entire works clear of water, for it was not possible to obtain strong and sound concrete work under water, whether the water was quiet or not, that is, if the materials were thrown in dry immediately after mixing. I had ascertained that concrete in the process of being deposited in this manner, and with only 1 in. of quiet water over its surface as deposited, even in the proportions of 3 to 1, was most seriously weakened by the separation of the finer particles of the cement from the body of the concrete.

In the year 1865, in concreting an outer apron of a graving dock between the pointing sill and the coffer-dam at low water, I had used Portland cement concrete in the proportions of 4 of Thames ballast to 1 of cement. It was all put in at the same time, in the same manner, with the same cement and ballast, and by the same men in quiet water of not more than 1 in. in depth above the concrete as it was laid. The concrete was then allowed to remain three months, and at the expiration of that time I had occasion to examine it, when I found that the portions nearest the abutments of the entrance were sound, but in the center, or rather in the part last closed in, a considerable portion was found to be quite soft; in fact, it was ballast which had retained but a mere fraction of cement, and what was retained of the cement had about as much strength as pipe clay. The whole of the defective concrete had to be removed and replaced with new concrete after the water had been excluded. To avoid such a contingency in future, I resolved that all Portland cement concrete before being deposited under water should, after mixing, be allowed to partially set. The time allowed for the concrete to set before being deposited depends upon the newness and fineness of the cement used, the proportion of the cement to the sand and stone, and the state of the atmosphere. If these conditions be not strictly adhered to unsatisfactory results will be obtained. By numerous experiments I found I was able to retain nearly the whole of the cement, and obtain a much stronger and better concrete, in proportion to the quantity of cement used, than by the ordinary methods. I referred to several specimens which I then exhibited. One was composed of one part of Portland cement and one of fine river ballast; this was thrown into 6 ins. of quiet water dry immediately after being mixed, was submerged 18 days, at the expiration of which time it showed the great separation that had taken place even it quiet water. A second specimen, similarly composed, was also thrown into 6 ins. of quiet water, but not until it had been allowed to partly set, after being mixed for about two or three hours in the open air previously to being submerged for 18 days. This specimen was so hard that it had to be split by a cold chisel and hammer, and had retained nearly the whole of the cement. Passing dry concrete down chutes, even with their lower ends somewhat buried in the newly deposited concrete, did not prevent separation from the coarser and heavier materials, which descended much more rapidly than the cement; for the cement, if very fine, which it should be for under-water work, has a tendency to remain in suspension, and thus the component parts of the concrete become washed or mechanically separated during the process of depositing. Generally in preparing concrete for under-water work it should be mixed with as little water as possible, and where feasible should be rammed solid into the skips, after a small admixture of Medina cement, allowed to remain for two or three hours, and then be gradually or slowly submerged beneath the surface of the water, so as to allow the interstices to become gradually filled up with water, after which the skips may be quickly lowered down to the work in progress.

Since the remarks I made in 1866 as to the use of Portland cement concrete *in situ* under water, I have had considerable further experience in the various harbor and sea works executed by myself, and likewise from the examination of works I have visited, executed by other engineers, and my former opinions have more than ever

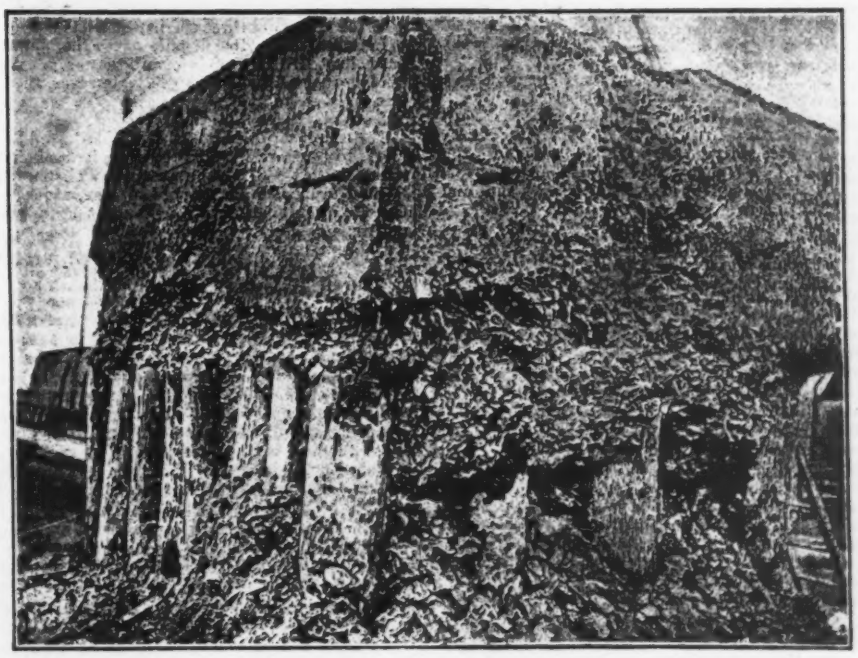


FIG. 6

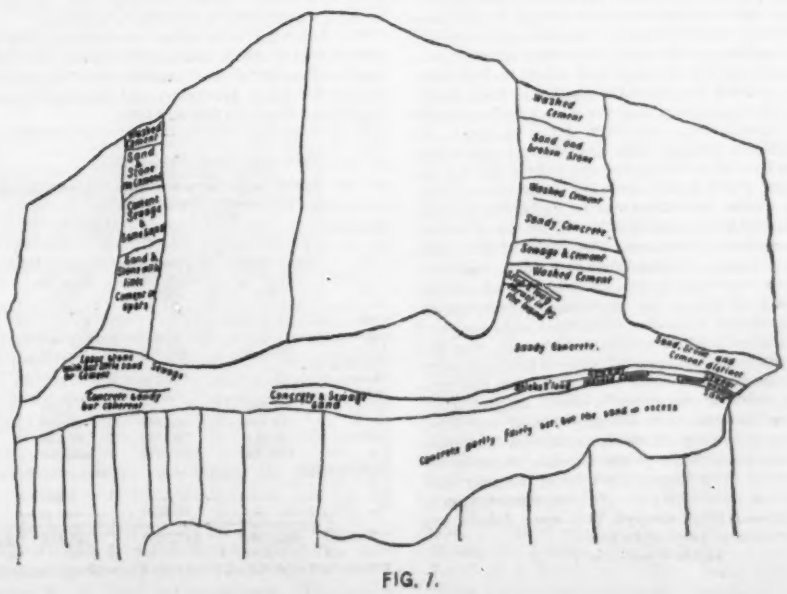


FIG. 7.

* See paper "On the Strength of Portland Cement." By John Grant, M. Inst. C. E., Proceedings of the Institution of Civil Engineers, Vol. XXV., page 125 (session 1865-6).

been confirmed as to the loss of strength and the uncertainty of obtaining sound work under such conditions, except at great cost for extra cement. As I have before mentioned, in order to guard as much as possible against the great loss of strength, I have in every work allowed the concrete to set one, two and three hours before being deposited in the work, or until it had become somewhat pasty or tacky, or just stiff enough to hold together while being passed through the water, but yet soft enough after it is deposited from the skips to fall to pieces, and to unite with the previously deposited concrete and so form sound work. At Greenock, Girvan, Wick, Quebec, and elsewhere, I have managed to get admirable work done by using partially-set concrete, where, if the concrete had been deposited immediately after mixing, much larger quantities of cement must have been used to obtain equally good work. However, under the most favorable circumstances, and where the greatest possible care is taken, there is always uncertainty about works constructed with concrete *in situ* under water, and if there were the same facilities for examination and detection of imperfect work done under water as for work done out of water, I am quite sure that engineers in the future would use it in connection with such works much less than they have done in the past.

I think I cannot do better than illustrate my remarks upon this point by reference to the condition of an experimental block of concrete constructed under the superintendence of General Newton, of the United States Army. The block weighed 80 tons, and the object of the experiment was to ascertain if the system of constructing some new quay walls then in progress in the North River, New York, was such as to secure sound work. The method pursued was to build a caisson, to lower it to the bottom of the harbor, deposit therein concrete in a similar manner and of similar proportions to what was employed in the construction of the quay wall, and when sufficient time had been allowed for the concrete to thoroughly set, the caisson with its contents was raised from the bottom of the harbor, its sides removed and the block of contrete examined. The caisson was about 10 ft. square, closely planked, and had a sloping face in front, corresponding to the batter of the wall, and short ends of piles were erected on the bottom of the caisson, similar to the bearing piles driven into the bottom of the harbor, and upon which the quay walls were built. After the caisson was completed it was sunk to the bottom of the harbor and filled with concrete, composed of one part of Portland cement to two parts of sand and four parts of broken stone. The materials as soon as mixed were filled into a skip having a sloping bottom and an opening side, and this was lowered through the water, and the concrete deposited. Next to the sides of the caisson forming the face of the wall, and at the corners of the caisson, the skips were guided in position and tipped by divers, so as to secure as sound work as possible. In order to make the block approximate as closely as possible to the quay wall, the caisson was not filled up in one day, but several days were occupied, the work thus being done in layers as in the quay wall. Five weeks after the caisson had been filled with concrete it was raised by a derrick crane, placed on shore, its sides removed, and the work examined. The removal of the sides was done with great care so that the concrete might not be disturbed. Several photographs of the different sides of the block were taken, one of which and a key diagram I have shown on Figs. 6 and 7.

The appearance of the block on the removal of the sides of the caisson was as follows: The faces were very ragged toward the bottom of the work, and on the river and south sides the ragged appearance of the faces extended to the top of the block. On the top of each layer of concrete (or day's work) there was a deposit of waste cement, which at the top of the whole mass was 6 ins. in thickness on an average. From this upper deposit a specimen was taken, and kept in a warm office for some weeks; there was no appearance of setting, and after it had been thoroughly dried it floated on the surface of fresh water. It would, therefore, appear that the cement had separated in a great measure from the bulk of the concrete, the heavier particles finding their way through the broken stone to the base of the block, and the lighter floating on the top; and this fact was borne out in the mass of concrete even where the setting was very good, the proportion of sand always apparently being in excess of that in which it was deposited in mass. The faces of the block against the planking exhibited very few stones, but there was a coating from ¼ in. to 3 ins. in thickness of cement, sand, and sewage having the appearance of stratified deposit. This coating, instead of being hard and capable of resisting abrasion from the rubbing of vessels, was soft and easily removed, and upon its removal strata were exposed of washed cement, sand, sewage deposit, and concrete, with more or less excess of sand. At the corners the defective work was more strongly marked, and in one place there was a cavity, of which the bottom and sides were of loose stones without any cement. An examination by divers of the subaqueous portion of the quay wall, which had been completed prior to the construction of the experimental block showed that were defects of a similar character to those in the block.

(To be Continued.)

Production of Steel, 1880-1890.

Census Bulletin No. 13 is a report on the production of steel in the United States during the year ended June 30, 1890, prepared by Dr. W. M. SWEET, special agent, under the direction of Mr. FRANK R. WILLIAMS, expert special agent of the Division of Manufactures. The tables presented show an aggregate production of steel of all kinds by States. The total production of steel in the form of ingots and direct castings aggregates 4,466,926 tons of 2,000 lbs. an increase of 290 per cent. over the production of the census year 1880, at which time steel was made in 14 States in the Union, as against 19 States engaged in that industry at the present time. The production of Bessemer steel rails has increased from 741,475 tons in 1880 to 2,036,654 in 1890.

The following table gives the production of the various kinds of steel in the form of ingots or direct castings in 1880 and 1890. A few steel works produce blister, cemented, and other miscellaneous steel, but the quantity made annually is very small, and the statistics thereof for 1880 and 1890 are not included in the table below:

Kinds of steel. (Ingots or direct castings.)	Year ending May 31, 1880.	Year ending June 30, 1890.
Bessemer steel	985,208	3,788,572
Open-hearth steel	84,302	504,351
Crucible steel	76,201	85,536
Clapp-Griffiths steel	.....	83,963
Robert-Bessemer steel	.....	4,504
Total	1,145,711	4,466,926

Pennsylvania continues to occupy the position of the leading producer of steel in the United States, producing 57% of the total production in 1880 and 62% in 1890. Illinois was second in rank in both years, and Ohio was third. From 1880 to 1890 the increase in production in Pennsylvania was 32½%, in Illinois 241%, and in Ohio 314%. Since 1880 the manufacture of steel has been abandoned in two States, viz., Rhode Island and Vermont, and seven States have engaged in its production, viz., Alabama, California, Colorado, Indiana, Michigan, Virginia and West Virginia.

Pennsylvania, Illinois and Ohio produced 88.68% of the steel production in 1880 and 91.41% in 1890. The Southern States have as yet barely made a beginning. The report continues:

The Clapp-Griffiths and Robert-Bessemer processes were introduced into the United States during the past decade, the former from Great Britain in 1884, and the latter from France in 1888. Both processes are modifications of the ordinary Bessemer method, but the converters employed are nearly all of small capacity. The first steel made in this country by the Clapp-Griffiths process was produced at Pittsburg, Pa., March 25, 1884. During 1890 seven works contained converters for the production of steel by this process, five of which were in operation in that year, producing 83,963 tons of steel ingots or direct castings. No new plants have been erected since 1887, and none are now under construction. The first steel produced in this country by the Robert-Bessemer process was made at experimental works at Springfield, O., in September, 1888. During 1890 there were six completed works containing converters for the production of steel by this process, and one plant was in course of erection. The process may be said to be still in an experimental stage, but the results that have so far been obtained by its use are reported to be encouraging. During 1890 there were 4,504 tons of Robert-Bessemer steel produced in this country, principally in the form of castings.

The following table gives the production of Bessemer steel ingots or direct castings (the figures for 1890 including the quantity of steel made by the Clapp-Griffiths and Robert-Bessemer processes) and Bessemer steel rails in the United States in 1880 and 1890:

States.	Bessemer steel ingots or direct castings. (Including Clapp-Griffiths and Robert-Bessemer steel.)		Bessemer steel rails.	
	Year ended May 31, 1880.	Year ended June 30, 1890.	Year end'd May 31, 1880.	Year end'd June 30, 1890.
Cal.	.....	.....	.....	5,654
Colo.	.....	17,992	.....	14,286
Illinois.	253,514	867,805	201,186	622,260
Indiana	.....	.....	.....	.....
Mass.	.....	15,753	.....	.....
Mich.	.....	3,600	.....	.....
Mo.	8,409	.....	5,100	.....
N. Y.	84,160	105,402	57,870	.....
Ohio.	82,811	385,576	66,480	17,335
Pa.	556,314	2,297,726	409,339	1,377,119
Tenn.	.....	.....	.....	.....
Va.	.....	.....	.....	.....
Vt.	.....	.....	1,500	.....
W. Va.	.....	183,225	.....	.....
Total.	985,208	3,877,039	741,475	2,036,654

The remarkable growth that has taken place in the Bessemer steel industry of this country during the past 10 years is well shown by the above figures. The increase in the number of establishments producing Bessemer steel has been the result almost entirely of the demand for steel in forms other than rails. All of the 11 Bessemer steel plants that were completed in 1880 had been built to manufacture steel for rails, many of them being added to previously existing iron rail mills. Of the 53 Bessemer steel plants at the close of 1891 only 14 made steel rails during that year, and of the total quantity of rails produced over 90% was made by 10 of these works. Thus, while the production of steel rails has nearly trebled in amount since 1880, the number of establishments engaged in their manufacture has shown but little change in the 10 years, although many of these works have greatly increased in size and efficiency. The competition in the manufacture of Bessemer steel rails has compelled many of the rail mills to convert a large part of the steel produced by them into forms other than rails, the production of rails to any considerable extent at the present time being possible only in works favorably located for the supply of cheap raw materials and operated under the latest and most improved methods of manufacture. Included in the total production of Bessemer steel rails during 1890 were 65,273 tons rolled in iron rolling mills from purchased Bessemer steel blooms.

OPEN-HEARTH AND CRUCIBLE STEEL.

The production of open-hearth steel in the form of ingots or direct castings during 1890 amounted to 504,351 tons, as compared with 84,302 tons made during 1880. In 1880 there were 25 establishments containing open-hearth steel plants, located in 10 States, and in 1890 there were 58 establishments containing open-hearth steel plants, located in 12 States. Since 1880 the manufacture of open hearth steel has been abandoned in two States, Vermont and Rhode Island, and four States have engaged in its manufacture, New York, Alabama, Indiana and California. During the past few years great activity has taken place in the erection of open-hearth steel plants, and indications point to a still larger production of this kind of steel during the next few years.

The crucible steel industry has shown but little progress since 1880, the production in that year amounting to 76,201 tons, as compared with 85,536 tons produced in 1890. In 1880 there were 36 establishments containing crucible steel plants, located in 9 States, while in 1890 the number of establishments had increased to 47, located in 11 States. For purposes requiring special grades of steel the product of the crucible process will be always in demand, but the high cost of manufacture prevents it in many instances from successfully competing in price with the other processes mentioned.

THE BASIC PROCESS.

The first basic steel made in the United States was produced experimentally at Steelton by the Pennsylvania Steel Co., on May 24, 1884, in a Bessemer converter. The beginning of the manufacture of basic steel in this country as a commercial product, however, dates from 1888, on March 28, of which year the first basic open-hearth steel was produced at the Homestead Steel Works of Carnegie, Phipps & Co., Lim. Since that date the manufacture of basic open-hearth steel has been continued at these works, and during 1890 this firm commenced the erection of 8 additional open-hearth furnaces for the manufacture of basic steel, of which number 4 are now in operation, and the remaining 4 furnaces are expected to be ready for working in a short time. When completed these works will contain 16 open-hearth furnaces prepared to manufacture basic steel. The manufacture of basic steel is now also regularly carried on at the Steelton works of the Pennsylvania Steel Co., where a combination of the Bessemer and open-hearth processes is used. During 1890 the Henderson Steel & Manufacturing Co., at Birmingham, Ala., produced steel experimentally by the basic process. Since the close of the year the Southern Iron Co. has successfully commenced the manufacture of basic open-hearth steel at its works at Chattanooga, Tenn. The Pottstown Iron Co., at Pottstown, Pa., has also produced steel by the basic process.

In Great Britain and on the Continent the basic process has been received with great favor, and large quantities of basic steel are made annually by all the leading iron and steel producing countries abroad. The wonderful growth of the steel industry of Germany and Luxemburg during recent years has followed the introduction of this process, the iron ores of these countries being especially suited to the manufacture of basic steel.

While the basic process is applicable to either the Bessemer or open-hearth process, its use in this country in connection with the open-hearth furnace is most promising of successful results, and the indications are that the growth of the basic steel industry of the United States will be largely in this direction. The total production of basic steel in the United States during 1890 amounted to 62,173 tons, nearly all of which was made by the basic open-hearth method, a small part being produced by the duplex process, a combination of the Bessemer and open-hearth methods.

A Simple Method of Ditching and Grading.

The device here illustrated and described was invented by Mr. D. D. ROGERS, of Ocala, Fla., while in charge of a considerable amount of ditching near the east coast of that State. His laborers were all negroes, unaccustomed to such work; so great difficulty was found in keeping them to grade. Under these circumstances the plan of setting up targets about the height of the eye above the bottom of the ditch suggested itself. Rods 5 ft. long were made, graduated in feet, numbered from the top so that the depth of cut as marked on the grade pegs could be laid off from the top of the rods; and targets set at these points would give a line parallel to and 5 ft. above grade. The negroes seemed to understand the system at once, and in a short time those of them who were able to read the numbers on the pegs could be trusted to set the targets. The inventor states that in this particular case, which included a great deal of soft rock work, about 5 cts. per cu. yd. was saved by the adoption of the device, and that full 2 cts. per cu. yd. could be saved in all work of a similar nature.

FIG. 1.

Considerable improvement has been made in the apparatus since first used by Mr. ROGERS, some 10 or 15 years ago. The rod and plain target are now made as shown in Fig. 1. The rod is of pine 1⅛ ins. in diameter, of equal circular section throughout, marked off in feet and twentieths. The target is 15 ins. long, of the form shown in the cut, and has a small level on the back to keep it horizontal. It is fitted to a collar, which can be slid up and down the rod, and set at any required point by means of a clamping screw. The manner of using these rods in cases where the work has been staked to grade is so simple as not to require description (see Figs. 2 and 3). Where there are both cuts and fills, as in Fig. 2, rods of extra length are required, reading both ways from a zero at the 5-ft. point.

The leveling instrument, Fig. 4, is used to set targets when the line has not been already staked to grade. Suppose, for instance, it is required to run a ditch with a fall of 1 in 1,000 from a certain point where the depth of the proposed ditch is known. The instrument is placed on one of the rods and slid down until the upper edge of the collar is at the mark on the rod which indicates the depth of the ditch. It is then clamped to the rod by the screw *A*. The sights are directed in the course of the ditch; clamped by the screw *C*, and leveled with tangent screw *B*. An assistant with a plain target is now sent down the line, say 200 ft. His target is leveled from the instrument, and afterwards moved by him 0.2 ft. further down the rod. In the same way another target is set 0.4 ft. below the level of the instrument and 200 ft. further down the ditch, thus giving a line of targets parallel with the bottom of the ditch and 5 ft. above it, which can be produced as far as desired.

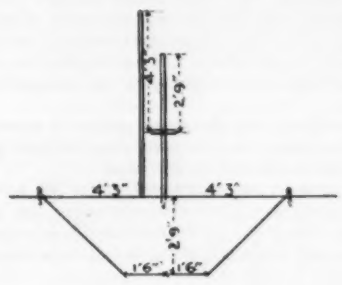


FIG. 5.

For setting slope stakes for ditches or for railway roadbeds (supposing a slope of 1 to 1) a rod is used as much over 5 ft. as half the width of the top of the roadbed or the bottom of the ditch. This rod is held on the line of targets and the point where the line intersects it is found. Then the portion of the rod above the line will be one-half the width of the top of ditch or bottom of roadbed at the point where the rod was held (see Fig. 5).

Other uses will suggest themselves to the engineer or surveyor, such as setting culverts before or after the embankment is built, bedding mud-sills, excavating for drain or water pipe, etc. The substance of the method in a cruder form has been quite widely used, but the instruments illustrated seem to have decided advantages.

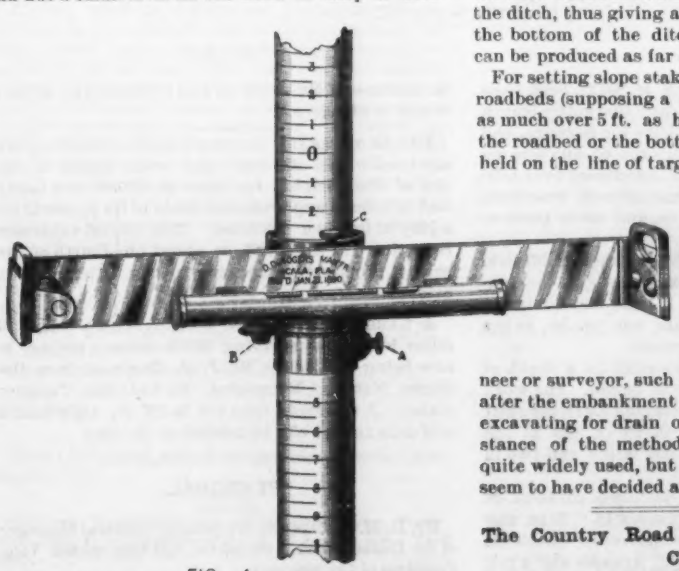


FIG. 4.

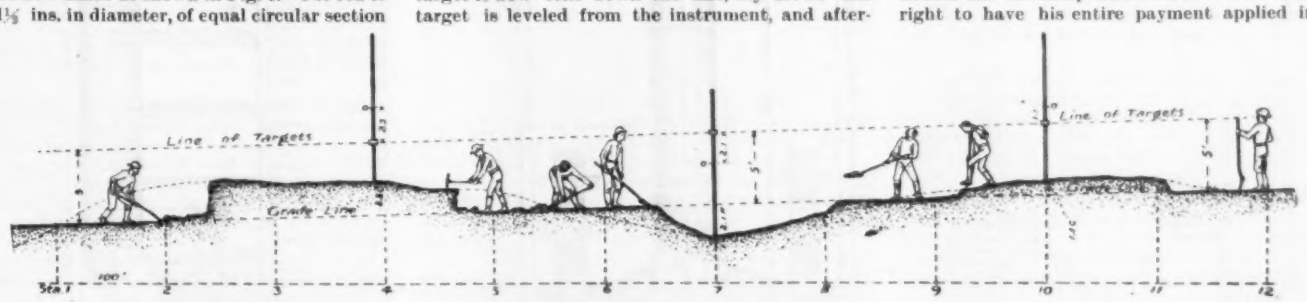


FIG. 2.

FIG. 3.

The Country Road Question in Allegheny Co., Pa.

The Allegheny Co., Pa., road convention held its meetings in Pittsburg, commencing Oct. 30, with Mr. GEORGE MCKEE, President, and Messrs. P. F. SMITH and W. H. ROBERT, Secretaries. The following recommendations were discussed and adopted: (1) Favoring the abolition of the present system of working out road taxes, and substituting a cash tax instead. (2) Favoring State aid to public roads. (3) Favoring distribution of this aid to the counties, instead of to townships; and ascertaining the amount of aid by valuation of assessable property, instead of by number of inhabitants, road mileage or otherwise. (4) Supervisors of roads should be paid, and their duty should be the assessment of taxes and appointment of road overseers having direct charge of work. (5) County engineers should attend to road making and act as superintendents; but the State aid should be handled as are the local taxes. (6) Allegheny County was classified as an agricultural, manufacturing and mining county, with (7) county stone fit for road making. (8) Favoring the borrowing of money by townships for road purposes. (9) The subject of convict labor on roads and in preparing road material caused a lively discussion, but was finally carried in the affirmative. These remmendations were ordered to be embodied in the general report to the Pennsylvania Road Commission, with the right to make further recommendations.

In support of these resolutions, Mr. PATTERSON said that the expenditure of $100,000 in his township, Chartiers, would enhance the value of the township $1,000,000. In regard to money borrowed by the townships, the meeting has yet to act on the detail of the resolution. As now before them this resolution would give the right to borrow to an amount equal to 5% of its taxable value and issue therefor 20-year 6% bonds. Any tax payer who would pay double his township assessment would have the right to have his entire payment applied in any local improvement of the roads that he may direct. The committee is to meet in two weeks and report to the State Commissioners on these and other resolutions before them.

English Ordnance Maps.

Capt. C. E. HAYNES, R. E., states that the large-scale maps of the Ordnance Survey are printed on double elephant machine-made drawing paper, the expansion of which, due to humidity, is greatest in its length. Being a hard paper, it is necessary to print from the zinc plate on damp sheets, which contract on drying, in length chiefly; consequently, the form on the plate should have a similar elongation. The negative is taken true to scale, and a photographic transfer prepared, after the Southampton method, on Evans' double elephant thin paper, which likewise has its greatest expansion in length. Previous to transfer to zinc, the transfer is damped until it has expanded to a certain convenient length—in practice, about ¼ in. beyond its correct size—and quickly passed through the zincographic press; the scraping action of the press increases the length of the transfer by a slight variable amount, which can be determined by experiment. The printer then obtains a stock of paper for printing that has been damped to such a degree of expansion as will contract on drying to the correct scale. In the paper-damping department a stock of printing paper is kept sorted in various degrees of expansion to suit the variable sizes of form on the zinc plates. Every sheet of paper used for printing is measured before being damped, after being damped, and again after being printed. Prints

with $\frac{1}{600}$ or .16 per cent. of error in scale are cancelled It is found that the elasticity of paper—*i. e.*, its capability of regaining its original form on drying after being damped—depends on its maturity, and that the maturity of a sheet depends on its age, and to a certain extent on its position in the ream.—*English Mechanic* (London).

The Niagara Falls Power Co.

In ENGINEERING NEWS for May 17 and 24 we gave a map and sections of the canals and tunnels proposed by the Cataract Construction Co., and a description of the geological formations which would be encountered in developing these remarkable plans. Since then the tunnel driving was begun, as already noted in these columns, and the following details have been adopted:

The company has decided to construct a tunnel of 490 sq. ft. section, shown in Fig. 1, on a slope of 0.7

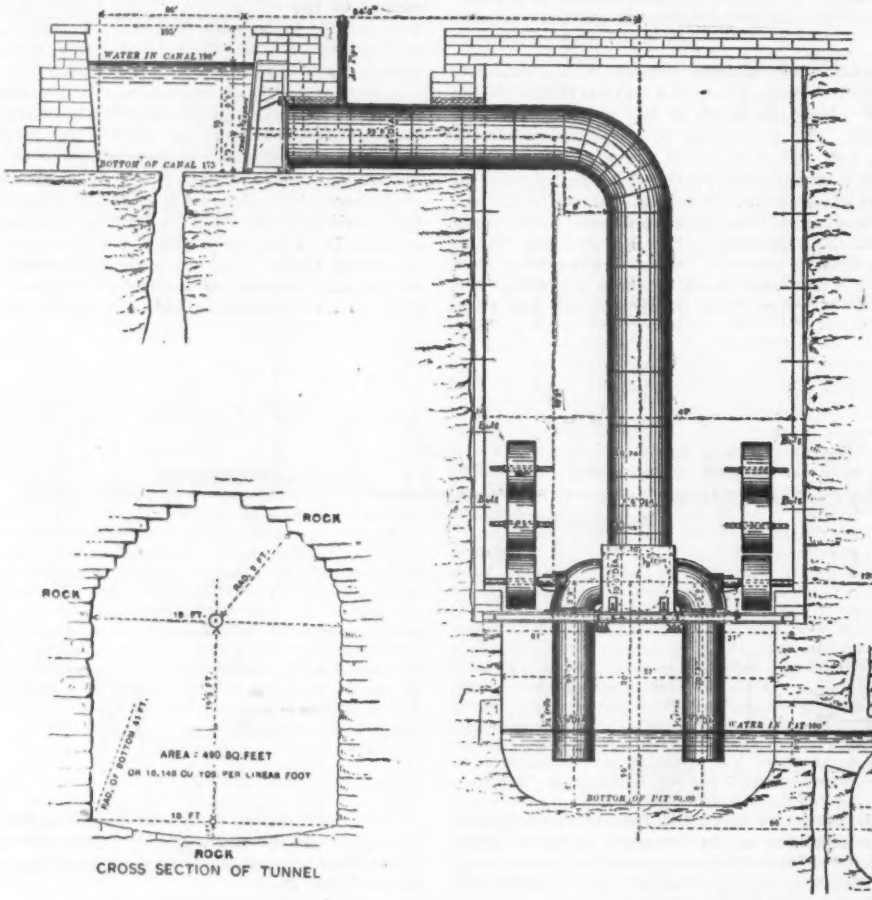


FIG. 1.

FIG. 2.

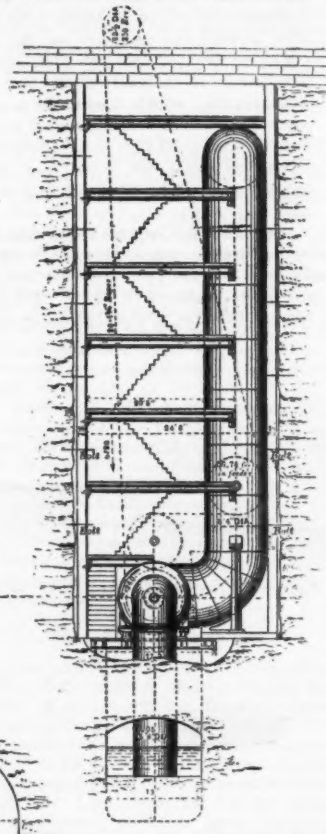


FIG. 3.

in 100 ft. While a circular tunnel running full would be of the form that would present the least surface resistance to the flow, yet the engineers have decided that the above shape is best adapted to the requirements. The section is rectangular, with a semi-circular arched roof; the width is 18 ft., height to spring of arch 19.48 ft., radius of arch 9 ft., radius of floor 41 ft.

The bottom of the tunnel, where it discharges into the lower river, will be, perhaps, more than 20 ft. below average water level so that when completed, only the arched roof will be shown above the river.

. While a canal 270 ft. wide, with 10 ft. depth of water flowing through it, at the rate permissible in an unwalled channel, would be required to convey the water from the upper river to the brink of the chasm made by the lower river to there develop the power now proposed to be applied to useful work, the same amount of power, it is assumed, can be obtained on the Evershed plan by means of a tunnel passing under the town, the sectional area of which is only 490 sq. ft., and in which a velocity can be maintained of over 25 ft. per second.

This tunnel will begin a short distance below the Falls, and extend in a straight line to a point 400 ft. from the river, about a mile above the Falls. From here the tunnel continues parallel with the bank for 1½ miles at an average depth of 100 ft. below the ground. It is connected with the river by means of surface conduits or canals, through which water is carried to the shafts and wheel pits.

The works are designed to develop 120,000 HP., and are divided, for convenience of construction, into three sections. The water passes through turbines, as shown in Figs. 2 and 3, and the power developed thereby will be transmitted to the surface, as shown in the cuts, whence it will be delivered by cable, pneumatic tube or electricity as the customers desire.

The company will also lease power to customers wishing to excavate their own wheel pits and put in their own wheels and connections.

The company has purchased about 300 acres of land, beginning a short distance above the upper boundary line of the New York State Reservation at Niagara, and extending along the shore of the river for 2 miles, at an average depth of 600 ft. back from the river, assuring to the company this entire length of river frontage with its facilities for dockage, and furnishing ample room for mill sites of any size desired. There have also been purchased over 1,000 acres of land adjacent to that already described, which will be used for mill sites, and more particularly for homes for operatives.

The contract under which the contractors Messrs. RODGERS & CLEMENT are working, calls for the completion of the tunnel by Jan. 1, 1892; the contracts for the canal and wheel pits are not yet let, as the final plans have not been approved.

Two shafts have already been sunk to a depth of 200 ft., and a 30° portal incline is begun. The work has all been done by hand, averaging 0.9 ft. per shift in the shafts and amounting to 200 cu. yds. at the portal; one shift working in the latter and two in the shafts.

The plant which is being installed consists of eight 100 HP. boilers, three duplex 18 × 30-in. and two single 12 × 16-in. Rand compressors, three Otis hoists of 25 HP. each, a 100-light dynamo and a full complement of blowers, pumps and other machinery. The boiler house will be 34 × 92 ft. and the engine house 40 × 112 ft., all located at shaft No. 2. Air will be conveyed from this point to shaft No. 1 in 6¼-in. pipes, and thence to the portal in 4-in. pipes. Compressed air will be used for the drills, hoisting and pumping machinery at the portal and shaft No. 1; at shaft No. 2 both air and steam will be employed.

THE AM. SOC. C. E. NOMINATIONS for officers for the ensuing year, as reported at the last meeting Nov. 4) by the Nominating Committee, are as follows: For President, OCTAVE CHANUTE; for Vice-Presidents, JOHN BOGART, CHAS. HERMANY; for Secretary, JOHN C. TRAUTWINE, JR.; for Treasurer, GEO. S. GREENE, JR.; for Directors, THEODORE COOPER, CLEMENS HERSCHEL, EDWARD P. NORTH, residents, and RUDOLPH HERING and S. WHINERY, non-residents. Of the ten nominees, five have been in the Board of Direction before, but only two are at present members of the Board. The most notable change is the nomination of Mr. JOHN BOGART as Vice-President instead of Secretary, and the nomination of Mr. JOHN C. TRAUTWINE, JR., as Secretary in his place.

THE SCHUYLKILL NAVIGATION CO., which a year ago tried to sell its canal and water-rights to the city of Philadelphia for over $6,000,000, has lately had an official appraisement made of its property by a jury of its own selection. This official valuation is set down at $1,539,221, or about one-fourth of the price it proposed to charge the city. The moral is evident.

A LARGE LUMBER AND WATER FLUME, some 43 miles long, and carrying 50,000 miner's inches, is now being located, by Mr. J. M. GRAHAM, from the Sierra Nevada Mountains to the San Joaquin plains. A reservoir dam 100 to 125 ft. high and a half-mile tunnel will be needed on the line.

PERSONAL.

Mr. D. H. GOODMAN, the present General Manager of the Union Switch & Signal Co., has been elected Vice-President of the company.

Mr. JOHN SCOTTI, said to have been the inventor of the locomotive cab, died Nov. 2 in Baltimore. He was connected with the Baltimore & Ohio R. R. throughout his life.

Superintendent McCOY, of the Buffalo Division of the West Shore R. R., has resigned, and succeeds Mr. E. G. ALLEN as Superintendent of the Hudson River Division of the New York Central R. R.

Mr. C. T. DABNEY, until recently with the Chesapeake & Ohio Ry., has been appointed Superintendent of the Buffalo Division of the Western New York & Pennsylvania R. R., vice Mr. HENRY DWYER, resigned.

Mr. J. B. ROHRER has been promoted from Resident Engineer, in charge of 40 miles of construction, on the Ohio Extension of Norfolk & Western Ry., to Division Engineer in charge of 90 miles of construction on the same extension, vice Mr. JOHN RAPELYE, resigned.

Mr. WILLIAM WASHBURN, one of Boston's leading architects, who died suddenly in that city Oct. 31, was a native of Lyme, N. H., where he was born Oct. 7, 1808. At an early age he came to Boston and here learned the carpenter's trade. In a short time he became a builder and rapidly advanced to the front, both in reputation and in amount of business. At that time there was no school of architecture in Boston, but Mr. Washburn by dint of his own personal enterprise and quick perceptions mastered the profession. Although he made a specialty of hotels, his attention was by no means confined to that branch, and a number of admirable public buildings, among the Tremont Temple, bear witness to his excellent taste. His method of roof trussing has never been equaled, and students of architecture are to-day taken to Tremont Temple to study the trussing there.

SOCIETY PROCEEDINGS.

Civil Engineering Society of the Massachusetts Institute of Technology.—Meeting of Oct. 30. The constitution was so amended as to abolish junior membership. Time of meeting was also changed to once in three instead of once in two weeks. The next meeting will be on Nov. 20. At this meeting Mr. A. G. ROBBIN described the application of graphics to some algebraic problems and Mr. F. H. KENDALL read a paper on "The U. S. Coast Survey."

American Society of Civil Engineers.—At the meeting on Nov. 5, the President, Mr. W. P. SHINN, read the report of the Nominating Committee for officers for the ensuing year. The nominations were as follows: President, OCTAVE CHANUTE; Vice-Presidents, JOHN BOGART, CHAS. HERMANY; Secretary, JOHN C. TRAUTWINE, JR.; Treasurer, GEO. S. GREENE, JR.; Directors, THEODORE COOPER, CLEMENS HERSCHEL, EDWARD P. NORTH, RUDOLPH HERING and S. WHINERY.

Mr. COOPER said that he thought the Nominating Committee ought to consult members nominated as to whether they would serve if elected. He had not been consulted and should certainly have declined the nomination.

Mr. CROES said that he was surprised at the report, as one of the nominations was contrary to the constitution and to the State laws under which the Society is incorporated. He claimed that officers must be Members, and that Associates and Juniors, not having voting powers, were not members in the sense required by law. He therefore considered that Mr. JOHN C. TRAUTWINE, JR., was ineligible for the office of Secretary, and that his name should be omitted from the list of nominations when presented to the Society to be voted upon.

The paper of the evening, on "Self Purification of Water in Flowing Streams; a Biological Consideration," was then read by the author, Dr. CHAS. G. CURRIER, M.D. The paper entered largely into bacteriology, described the methods of testing water for bacteria, etc., and referred to examinations made by the author on the water of rivers in various parts of the country. The paper was of an important character, although not of very general interest. After some little discussion Mr. FTELEY suggested that, as the subject was one of importance as regards water supply, and the time was late, Dr. CURRIER should be invited to continue his remarks at another meeting. The invitation was accepted by Dr. CURRIER.

The following candidates were declared elected:

MEMBERS.

FRANCIS R. FAVA, Prof. of Civ. Eng., Corcoran Scientific School, Washington, D. C.

ALEX. E. KASTL, First Asst. Eng., Panuco Riv. Impt., Tampico, Mex.

JOHN N. OSTROM, Bridge Engineer, New York City.

JAMES RITCHIE, Pittsburg Testing Laboratory, Pittsburg, Pa.

ASSOCIATE.

HENRY S. JACOBY, Asst. Prof. Civ. Eng., Cornell Univ., Ithaca, N. Y.

JUNIORS.

HENRY L. DAVIS, City Eng.'s Dept., New Haven, Conn.

WALTER L. DUSENBERRY, Dept. of Parks, New York City.

GEO. H. PAINE, Union Switch & Signal Co., Swissvale, Pa.

LEE TREADWELL, Pacific Short Line Bridge Co., Sioux City, Ia.

A. L. SHREVE, City Eng.'s Dept., Baltimore, Md.

Western Society of Engineers.—Meeting of Oct. 1, 1890, President L. E. Cooley in the chair, and some 60 members and visitors present.

Mr. O. Chanute, for the Committee on "Bridge Legislation," stated that the committee had had some meetings. It has entered upon the gathering of data and has succeeded fairly well in getting some of them. The committee has undertaken to ascertain, first, what legislation concerning bridges has been had in foreign countries, and it has obtained the legislation in Great Britain, France, Austria and Germany, of which it will give an abstract in its report. It has also obtained the data concerning legislation heretofore proposed in the United States, and has also obtained data concerning the practice of the leading railroads in the United States, more especially in regard to bridge floors, which is considered the one important thing for legislation to touch upon.

Mr. Isham Randolph then read an interesting paper on "Railroad Signaling and Interlocking."

Mr. HANSEL, Consulting Engineer of the Railway and Warehouse Commissions in discussing this paper said, in regard to couplings: "I have a great deal of respect for the action of the car builders, and think that, while we have not yet got hold of the ideal coupler, that if we settle upon a type, the inventor will give us the proper design. As uniformity in everything is what we ask for, I am against any action of our State Legislature as regards any safety appliance which is not only interstate but international. We all know that our traffic is not confined within the United States. It goes to Canada and old Mexico, and any law that any State would pass would be an evil. I have advocated the idea that if the Congress of the United States would pass a law requiring couplers and air brakes of a certain style on all cars as they were repaired, and all new cars as they were sent out, and the provisions of this law were carried out in each State through its commissioners, it would be a good thing. Massachusetts and some other States have asked Congress to authorize the Interstate Commerce Commission to handle this subject. I think if the commissioners of all the States were authorized to act in this matter, they could do it. Figuring 557 cars for each 100 miles of railroad operated, we would have something like 55,000 freight cars in Illinois, and there are 237,000 freight cars owned by companies operating in Illinois. If we count on 19 engines for each 100 miles of operated line in Illinois, we would have 1,800 engines, which to equip with air brakes on engine and cars would cost over $3,000,000, or 8½% of the gross freight earnings of all the companies of Illinois, so that we see that we cannot command the introduction of any device of this kind except by degrees.

The Master Car Builders have been the only society who had nerve enough to come forward and say "We will adopt a certain line of car coupler," a certain type of air brake. Commissioner Mason says, in his annual report of '89, that the introduction of automatic couplers has not been attended with the result he hoped for, and I think that no good will come out of the automatic coupler question until Congress says that the type of coupler shall be so and so. I do not mean to say that the style and device should be exactly so, but the type shall be so and so. After they have decided that question it is easy enough for each State to act in harmony. Otherwise, the State of Michigan will allow them to put in any one of the thous. and types that we have, whereas Ohio would select a few and Indiana would select a few—all different so that it does not seem to me that any action of State Legislature will ever solve the problem.

Further discussion followed, by the President and Messrs. Randolph, Strobel and Williams.

JOHN W. WESTON,
Secretary.

Western Railway Club.—At the meeting on Oct. 21, the first subject discussed was steel-tired wheels, Wm. Forsythe Chairman of the Committee appointed upon the topic, repeated his statement made at a former meeting that on the Chicago, Burlington & Quincy, the swing beam truck is costing so much more to maintain than the rigid trucks that it is gradually being abandoned. He quoted from the report of the Committee of the American Society of Civil Engineers on Rail and Wheel Sections. the paragraphs referring to causes of sharp flanges, and read the following letter from a member of the Committee, written in response to his inquiry for any difference in flange wear observed with the two classes of trucks.

NEW YORK, Oct. 17, 1890.

WM. FORSYTH, ESQ., C., B. & Q. R. R. Co., Aurora, Ill.

DEAR SIR.—Your letter as to the "comparative effect of swing bolster trucks and flange wear of wheels," has been duly received.

I do not wonder you find it extremely difficult to get any definite information on the subject, for if any definite information exists, I do not know of it. I have sought for it very carefully at various times, but all I can give is an opinion based upon general observation. That opinion is, that swing bolsters do have a beneficial effect upon wear and tear in this respect: that they prevent the tremendous inertia of the car body from violently driving the flanges of the wheels against the rails whenever there is any imperfection of track or truck. Otherwise than in this respect, I regard it as quite certain that swing bolsters have no effect whatever on curve resistance. This becomes clearer when we remember that the *real car* after all is the truck, and the car body is merely a dead load resting upon it. Just so much effect in easing the motion as would be obtained by swinging any other heavy load carried on the car body in slings, is obtained by using swing bolsters *and no more;* and this is merely to ease off the more violent motions. On the other hand, I think in certain cases the swing motion may have a somewhat *injurious* effect on safety, by prolonging the pressure of impact after the wheels have struck, and so creating more tendency for them to mount. Of one thing I feel quite certain: that a very large proportion of the derailments commonly ascribed to spreading of rails, bad gauge, wrong flange, and unexplained causes, are in fact, due to such mounting for no obvious reason. I therefore do not regard swing bolsters as an extremely important appliance, but on the whole, I believe they do good enough to justify their existence.

There is a broad distinction between swing motion of car trucks and of locomotive trucks, owing to the fact that the last is rigidly attached to a long heavy controlling wheel base, while the car truck is not. The mechanics of the locomotive truck you will find very fully discussed on pp. 421-434 of my book on the Theory of Railway Location, chapter on Locomotive Running Gear. I can add nothing to this discussion.

Yours truly, A. M. WELLINGTON.

Mr. Forsyth called special attention to the statement that while shocks may be eased by the swing beam truck, when they occurred there was a tendency to hug the rail which might be dangerous. His conclusion was that there was not enough gain in the swing beam truck to justify its extra first cost and expense of maintenance.

The Secretary read a letter from J. C. Barber, M. C. B. No. Pac. Ry., objecting to the ordinary patterns of swing beam trucks because of their numerous parts, especially the spring hangers, which require welding, as this is often imperfectly done, also the coil springs, which are subjected to a heavy rocking strain. He favored, however, a swing beam truck, made with short hangers, to limit the swinging motion within narrow limits, and stated that his experiments showed that such a truck saved 20% in wear of flanges and journal bearings over the rigid truck. The maximum swinging motion should not be more than ¾ in. or less than ¼ in. each way from the center. The trouble with swing trucks, as ordinarily built, is that they are permitted to swing from 1½ ins. to 4 ins. each way from the center. It is unfair to compare such a swing truck with the latest modern designs of rigid truck.

As to side bearings not curving properly, the fact is that the proper use of side bearings is merely to prevent the rocking motion of the car. Increase the size of the bolster so that it will not spring down under a heavy load, and there will be no more trouble with the side bearings binding when the truck rounds a curve.

It has also been said that a swing bolster springs backward and forward in switching and springs the iron truck transoms outward. The cause of this is faulty construction. A swing bolster that bears against the iron transoms for the full length will never spring the truck transom, except perhaps in severe wrecks.

Mr. Barber also sent a model of the swing beam truck which has been used for 6 years on the Northern Pacific As compared with the old pattern, the number of separate parts has been reduced over 80 per car, the first cost has been reduced 12½%, the maintenance has been reduced fully 60% and the capacity has been doubled.

Mr. Verbryck brought up the matter of the swing beam trucks used on passenger cars to make them ride easily. Mr. Hickey explained that with the small amount of swing permitted on a passenger car truck it was practically a rigid truck. Mr. Gibbs said the Chicago, Milwaukee & St. Paul was in favor of the swing beam truck, but had adopted a rigid truck for their cars of large capacity. The swing beam truck is a failure when loaded beyond its capacity. Mr. Cooke said that swing beam trucks worked very well until loads of 40,000 lbs. or upward were put on them. Then they swing to one side and draw harder than a rigid truck. He had noticed no difference in flange wear.

Mr. Schroyer and Mr. Barr defended the swing beam truck. The former thought the side motion which it permitted might be necessary in using the M. C. B. drawbars. The latter referred to experiments in carrying a bucket of water on a rigid truck car and on a swing beam truck car. The first spilled nearly all the water out of the bucket, but the swing beam car spilled out only half to three-fourths of the water. It was argued from this that the swing beam truck carried both the car body and the freight contained with less injury than the rigid truck. Mr. Mackenzie criticised the experiments, however, as not fairly made.

Mr. Rhodes gave the difference in first cost on the C., B. & Q. as $3.50 per truck in favor of the rigid truck. He expected to make as great a saving in cost of repairs as in first cost. Mr. Mackenzie suggested that the rigid truck was the best where roads were kept in first class condition; several members, however, said that if that was the case there was still great need of the swing beam truck. Mr. Darrall favored the swing beam truck and promised to submit statistics showing the decrease of flange wear and increased life of wheels since that truck was adopted on the Illinois Central.

After the intermission Mr. G. W. Rhodes read a paper on "Steel-tired Wheels and Methods of Fastening Tires" [abstracted in another column]. At the meeting on Nov. 18 Mr. Rhodes' paper will be discussed, and Mr. C. A. Schroyer will present a paper on "Draft Rigging."

ENGINEERING NEWS

AND

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Technical Society of the Pacific Coast.—Next meeting Dec. 5, Secy., O. von Geldern, 408 California St., San Francisco.

Association of Civil Engineers of Dallas.—Next meeting, Dec. 5, Secy., E. K. Smoot, Elm and Austin Sts.

New England Railroad Club.—Next meeting, Nov. 12, Secy., F. M. Curtis.

Engineering Association of the Southwest.—Next meeting, Nov. 13, Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Engineers' Club of Minneapolis.—Next meeting, Nov. 13, Secy., F. W. Cappelen.

Engineers' Club of Philadelphia.—Next meeting, Nov. 15, Secy., Howard Murphy, 1122 Girard St.

Western Railway Club.—Next meeting, Nov. 18. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery, Bldg.

American Society of Civil Engineers.—Next meeting Nov. 19. Secy., John Bogart, 127 E. 23d St., New York.

Boston Society of Civil Engineers.—Next meeting, Nov. 19. Secy, S. E. Tinkham.

New York Railway Club.—Next meeting, Nov. 20. Rooms, 113 Liberty St.

Engineers' Club of Cincinnati.—Next meeting, Nov. 20, Secy., J. F. Wilson.

Engineers' Society of Western Pennsylvania.—Next meeting, Nov. 21. Secy., S. M. Wickersham, Pittsburg, Pa.

Denver Society of Civil Engineers.—Next meeting, Nov. 24. Secy., Geo. H. Angell.

Civil Engineers' Society of St. Paul.—Next meeting,

Engineers' Club of St. Louis.—Next meeting, Dec. 8. Secy., W. H. Bryan, 30 South 7th St.

Civil Engineers' Association of Kansas.—Next meeting, Dec. 8. Secy., J. C. Herring, Wichita, Kan.
Dec. 1. Secy., G. L. Wilson.

Civil Engineers' Club of Cleveland.—Next meeting, Dec. 9. Secy., A. H. Porter, 50 Euclid Ave.

Western Society of Engineers.—Next meeting, Dec. 9. Secy., J. W. Weston, 280 La Salle St., Chicago.

THE nominations for officers for the ensuing year of the American Society of Civil Engineers, as given in another column, are of more than usual interest in the change made in the important office of Secretary, Mr. JOHN BOGART being nominated as Vice-President instead of Secretary, and Mr. JOHN C. TRAUTWINE, Jr., being nominated in his place for the latter office. Such a change has been more or less expected for several years, Mr. BOGART'S multiplying professional engagements having seemed to make the change imperative, but the difficulty of finding a suitable candidate to succeed him (which has at last, we think, been most satisfactorily met) and the general appreciation of his long and in many ways important and distinguished services to the society and qualifications for the office, have postponed the change until now, although for several years he has been able to give only a small fraction of his time to the business of the society; which, if the society is to flourish as it should, imperatively demands the constant and undivided attention of the Secretary himself, and not merely of clerks under him. Mr. BOGART became a member of the society in 1869, about two years after its reorganization, when the society numbered about 100 members only. He became a director in 1872, treasurer in 1875 and secretary in 1877, so that he has held office continuously for nearly 19 years, during all of which period he has taken a leading part in the management of the society's affairs. In retiring from the office which he has held so long he will carry with him the best wishes of the membership generally, and he will be generally felt to well deserve the nomination to the higher but less exacting office for which he has been named.

THE new nominee for Secretary, Mr. JOHN C. TRAUTWINE, Jr., unites in one person more of the qualities which go to make the ideal Secretary than can often be found, unless by some rare chance. He bears an honored name, known to engineers throughout the world; he is perhaps as thoroughly versed in engineering literature as any one engineer in America, and so will make an admirable editor of the society's transactions, and guardian of its library, the last of which, as we have often said, has been for some years in a deplorably neglected condition. At the same time Mr. TRAUTWINE some years ago definitely gave up the active practice of engineering, and in consequence still remains an Associate only of the Society, as is Mr. JAMES FORREST of the Institution of Civil Engineers, although the Institution could much better have afforded to lose some dozens of its full members than the services of Mr. FORREST, who has played a leading part indeed in making the Institution, to which he has devoted the thought and energies of a lifetime, what it is to-day. We deem it for many reasons highly desirable that the Secretary of a society of engineers should not be himself a practicing engineer, and yet, it will rarely happen that a man who is not himself in practice will have the necessary intimate knowledge of engineering and engineers which Mr. TRAUTWINE has. He is also, to our knowledge, one of the most systematic and energetic of men, and thoroughly familiar with printing and publishing practice, qualities of great importance in an efficient secretary; and last, but not least, he is in his personal and social qualities, it seems to us, admirably suited to the place. It is not to be expected that any successor will unite in his person all the admirable qualifications for the office of the retiring secretary; few men do; but on the other hand, Mr. TRAUTWINE has decided merits of his own which make us feel sure that in his hands the interests of the society will not suffer; but rather, that its influence and usefulness will go on widening and broadening.

THE question of the right of the society to elect an Associate to the office of secretary was raised at the meeting by one member only, as noted in another column; but he found no seconder to his objections, nor is it surprising that he did not, since both the constitution of the society and the law of the State of New York are perfectly clear on the subject. The law of the State under which the society is organized, says:

> Any five or more persons may associate themselves [etc.] The persons who shall have signed and acknowledged such certificate and their *associates* and successors, shall be a body politic and corporate . . . to elect and appoint the officers and agents of each society. . . . The society so organized may annually elect *from its members* its trustees, directors or managers, *at such time and place, and in such manner, as may be specified in its by-laws.*

Now, let us see what those "by-laws" say, as to who is a "member," in Art. II., Sec. 1, of the late codification:

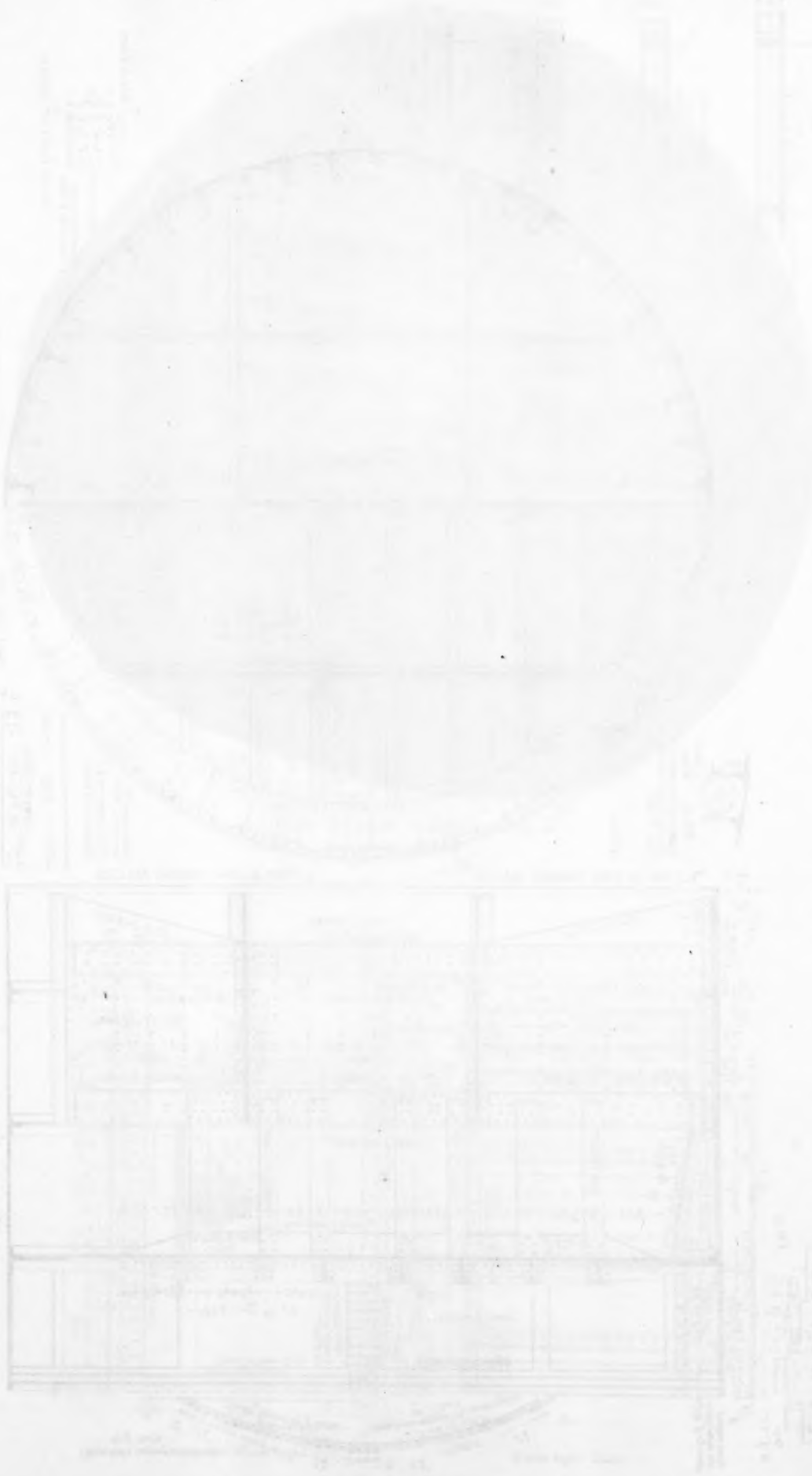
> *The Active Members* of the Society shall be divided into *three* classes, to be styled, respectively, Members, *Associates* and Juniors. *Associates and Juniors shall possess* ALL *the rights and* PRIVILEGES of Members excepting the right to vote.

If the right to be nominated and elected to office is not one of the "rights and privileges" of members, which is distinct from and in addition to that of voting, what is it? And by this clause it is distinctly and in the broadest terms conferred upon all of the three classes of "active members"; nor is there anywhere else even the remotest implication to a contrary effect. Thus, it was entirely within the power of the Society to have specified in its "by-laws" that the President, Secretary, or any other officer, must be a full member, or a member of a certain number of years' standing, or a resident of New York City, or conform to any other condition not of an unlawful nature which it chose to impose. It has done none of these things, and therefore the express words in which it does convey any and all such privileges are not to be explained away nor curtailed by any arbitrary interpretation. It would be contrary to both the letter and spirit of the constitution to deprive the Society of the right to elect an Associate as Secretary, or President, for that matter, should it see fit to do so.

UNDERGROUND New York is represented by the following material buried beneath its 359 miles of paved streets: About 10 miles of traction cable for street-car service; 435 miles of sewers; 5,220 receiving basins; 675 miles of water mains; 1,220 miles of gas mains; 115 miles of electric subways; 3.12 miles of pneumatic tubes; 3 miles of salt-water mains; 1½ miles of oil pipe and about ½ mile of refrigerating pipes. This list, taken from The *Sun* of Nov. 2, does not include the troublesome steam-heating plant, nor the many thousands of stops, gates and manhole openings necessary in the streets to operate the net work of pipes and conduits enumerated. The list is especially interesting when taken in connection with the exhibits in our last issue, showing what this tangle now means in certain localities.

The Commissioner of Public Works has accomplished much, in a negative way, by insisting upon the completion of all underground work before the new pavements are laid and in limiting, as much as possible, the number of such subterranean pipes and conduits. But while this may do for a time it is not of permanent value, as a new gas company, for example, may come at any time armed with power from Albany, to tear up the new pavement; the city aldermen may grant new vault-permits beyond the curb-line and there is no telling what corporations may next appear with a scheme for burying mains for compressed air or high-pressure water for power, fuel-gas, or something of that sort.

The people of New York will soon, despite all questions of political advisability or of cost, be compelled to face the problem of providing some channel, independent of the street surface and street traffic, for the disposal of this material. The day is close at hand when, for its main arteries of travel, at least, New York must practically have two streets, one over the other; one devoted to the uses of citizens and their commerce, and another one, entirely distinct, in which to handle the pipe plant that is just as essential to the comfort and



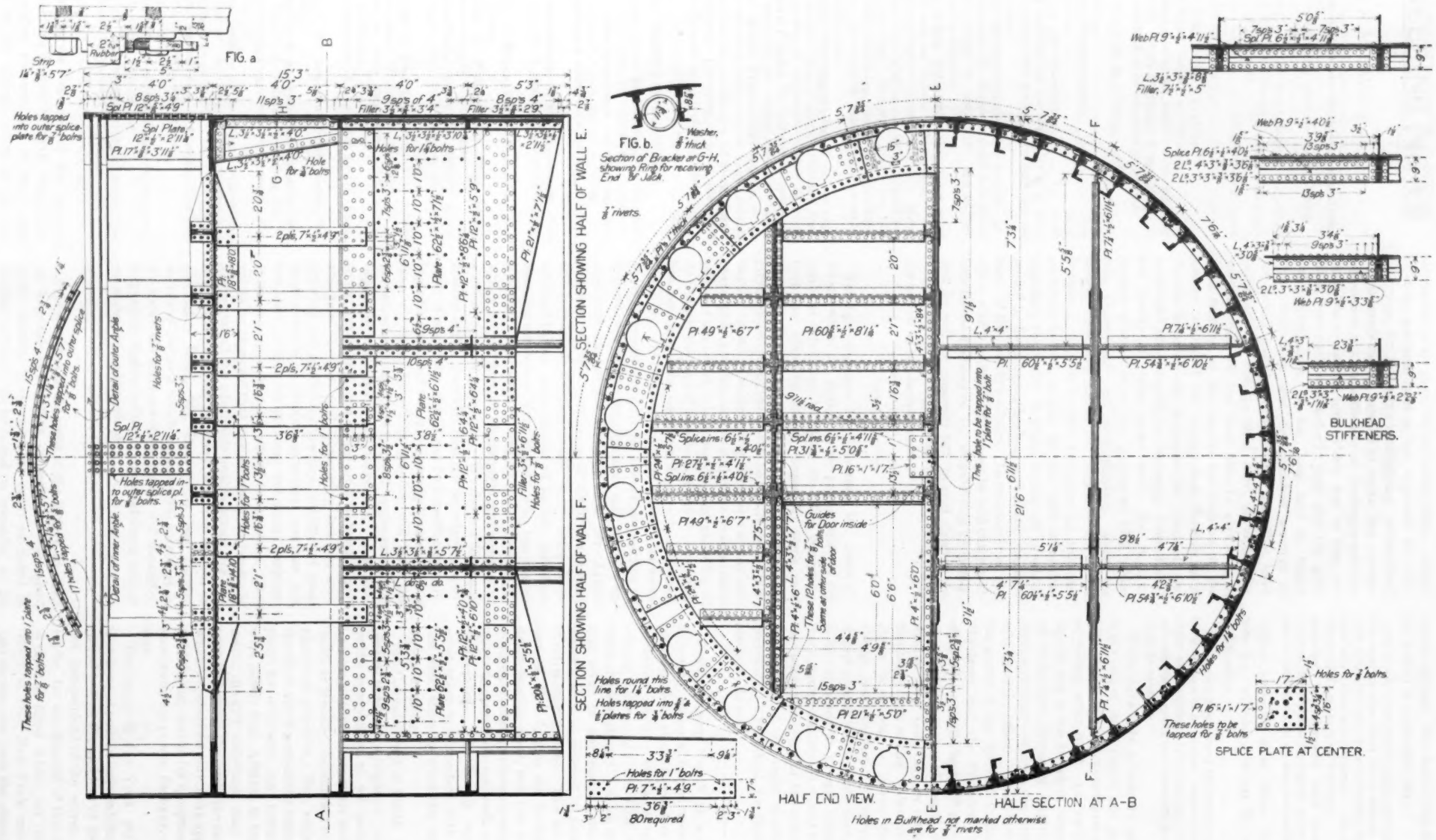
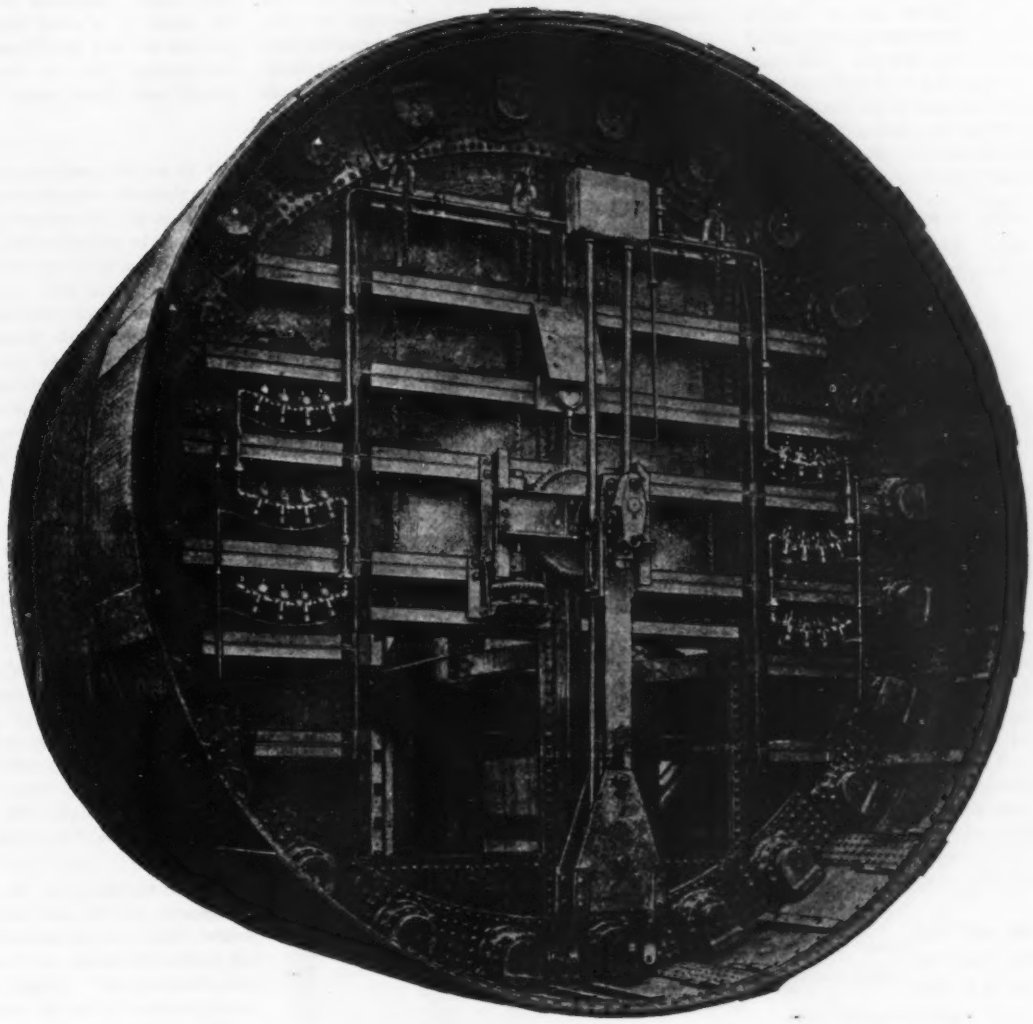


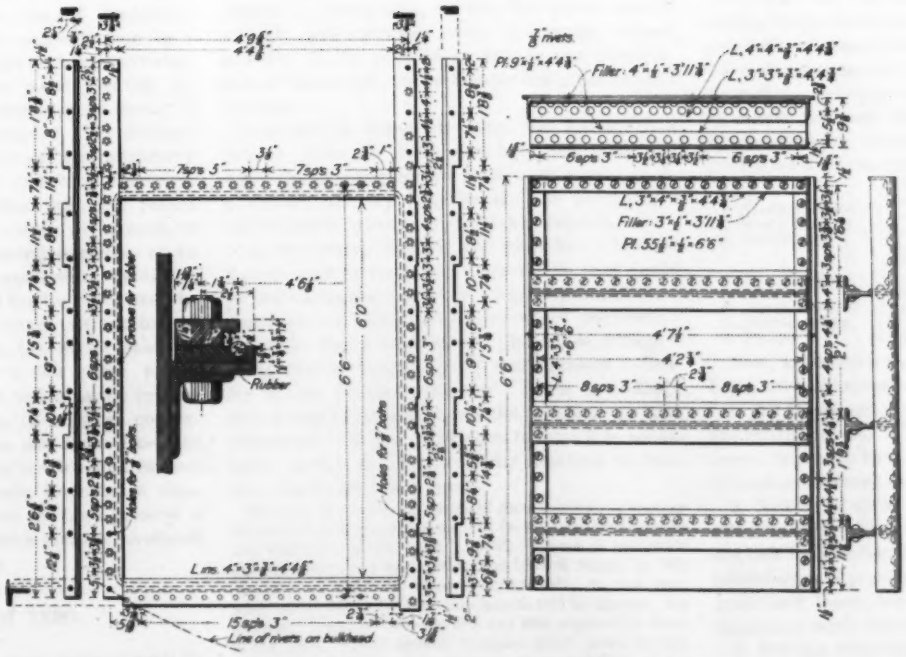
FIG. a
SECTION SHOWING HALF OF WALL E.
FIG. b.
Section of Bracket at G-H, showing Ring for receiving End of Jack.
SECTION SHOWING HALF OF WALL F.
HALF END VIEW.
HALF SECTION AT A-B
BULKHEAD STIFFENERS.
SPLICE PLATE AT CENTER.
Holes in Bulkhead not marked otherwise are for ⅞" rivets

LONGITUDINAL AND TRANSVERSE SECTIONS AND HALF END ELEVATION OF SHIELD FOR THE ST. CLAIR TUNNEL.



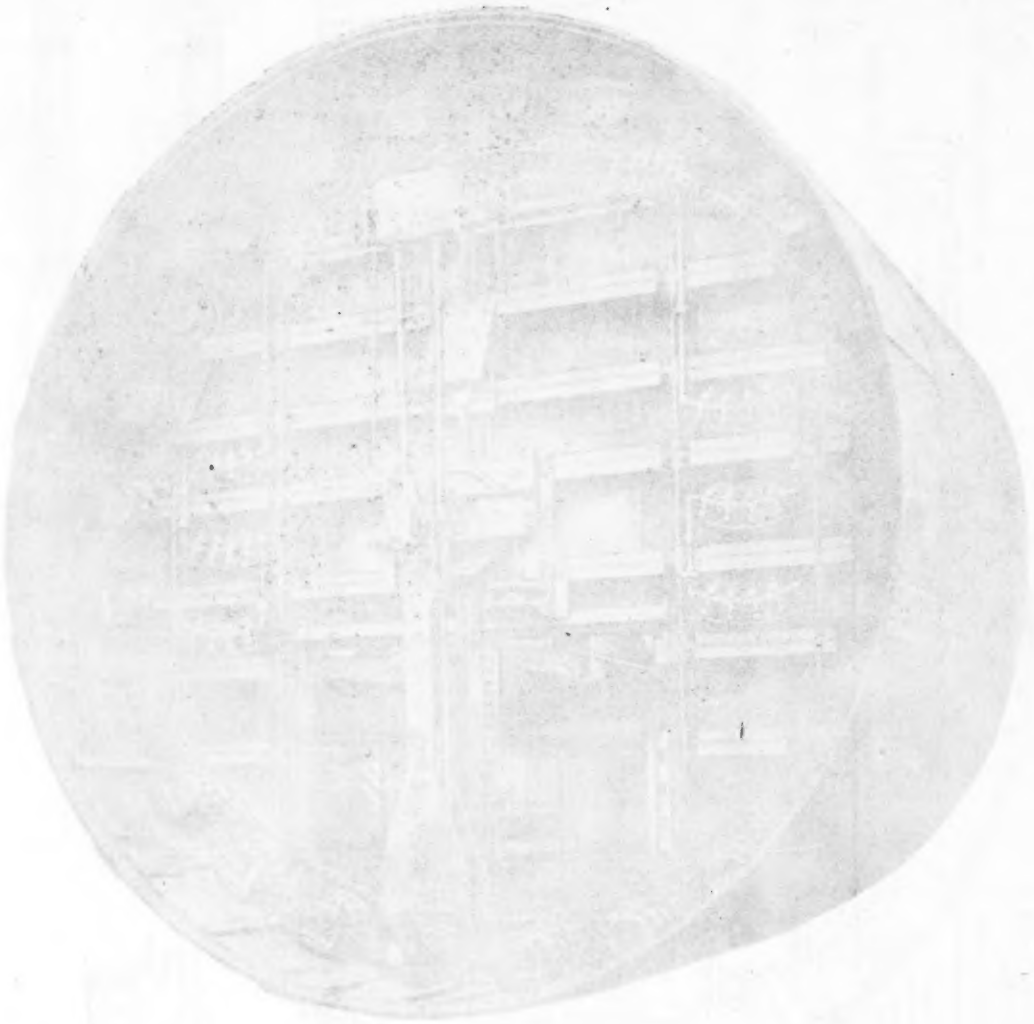
THE ST. CLAIR TUNNEL SHIELD.

From a Photograph.



Frame for Water-tight Door. Water-tight Door.

THE ST. CLAIR TUNNEL SHIELD.



material well-being of citizens. This plan "comes high," but we must have it in time, on Broadway, the Bowery and Sixth Ave., to say the least; by temporizing we are only postponing the evil day and making more costly the future solution of the problem.

FROM the description in another column of the process of aluminum production by electrolysis in use by the Pittsburg Reduction Co., an idea may be formed as to the cost of production of the metal when the process is carried on in the most efficient and economical manner. The materials which must be consumed to produce one pound of aluminum are approximately one pound of carbon, costing about 3 cts. per pound, and two pounds of prepared bauxite, costing 5 cts. per pound. To extract the metal from the ore about 23 electrical HP. is required for one hour. This probably requires about 28 indicated HP. for one hour. Taking the cost of steam power in Pittsburg as $35 per HP. per year, the cost of the power required per pound of aluminum would be about 11 cts. The cost of the labor at present employed is probably between 5 cts. and 10 cts. per pound of product, but it could certainly be reduced to or below the latter figure in operating a very large plant.

Aside from the engines and boilers, the only part of the plant which is at all expensive is the dynamos, which have to be specially made; and while their depreciation may be small, their first cost is very large. The cost of these and of real estate, with the many other necessary expenses attendent upon the establishment of a new industry, we will not attempt to estimate.

THE point which is of most interest is that the expenses necessarily involved in the process are very small. The improvements in detail which are reasonably certain to be made will reduce the present expense very largely. The greatest gains are to be expected from the use of cheap power, cheap ore and cheap carbon. As regards the first, by the choice of a suitable site, where cheap water power could be secured, its cost ought to be reduced as low as $10 per HP. per year, or about 3 cts. per lb. of aluminum produced. By developing American deposits of bauxite, the cost of the ore ought to be reduced, say, to 5 cts. per lb. of aluminum produced, and possibly by the use of improved methods of purification and concentration to a much lower figure. As for the carbon electrodes, it may yet be possible to use wood charcoal or some similar cheap and reasonably pure material whose cost will be almost nominal. No attempt has yet been made to use labor-saving machinery about the reducing pots and remelting furnaces, but when this is done the labor cost per pound should also fall to one or two cents per pound, or even less. The only remaining expenses to be considered are the interest, taxes, etc., upon the considerable capital required for the plant and the cost of its maintenance. Without attempting to estimate these, it seems from the above that we may reasonably expect in a few years to see aluminum produced at a cost as low as the present price of tin, and possibly as cheaply as copper. Much lower than this it does not seem likely to go, so far as can now be seen, nor would a further reduction be of any economic importance compared with the reduction from the high price of a few months ago to prices which make it available for countless uses in the arts.

The Census of 1890.

One of two conclusions of great moment must be accepted in regard to the census returns just published. Either a social change of quite unprecedented suddenness and importance has taken place in this country, or the census just taken is gravely defective, not at one or two points only, but quite generally throughout the country. In the effort to determine which horn of this dilemma must be accepted we have, with no small labor, made an analysis which is in part subjoined of all the successive censuses since the first one of 1790.

We are unable to resist the force of the evidence that the main cause for this apparently startling change lies in serious and widely distributed errors of omission in the census, and this at least is quite certain, that the arguments advanced in the 12th Census Bulletin in defence of the unexpected results announced, are in large degree transparently unsound; indicating either great carelessness in studying the facts of record, or a disingenuous attempt at special pleading which will justly react to create or intensify distrust.

The pith of the difficulty lies in this: Whereas all past ratios of growth had led to the confident expectation that the census of 1890 would show a population somewhere between 65 and 66 millions, the actual population returned by the census is only 62.48 millions, a falling off of about 3 millions, or of nearly 20 per cent. in the expected increase of upwards of 15 millions, and this in the face of the fact that the immigration during the last decade has been far in excess of all precedent, in fact, nearly double the largest ever reported in any previous decade. The main facts as to all previous censuses of the entire country, taking the official records as they stand, may be thus tabulated, the war decade being enclosed between rules:

POPULATION AT EACH CENSUS OF THE UNITED STATES.

Census.	Population in *thousands.*	Per cent. increase.	Immigrat'n in decade *thousands*	Per cent. incr. less im'igra'n.
1890	62,481	24 57	5,247	14.11
1880	50,156	30.08	2,812	22.81
1870	38,558	22.63	2,398	15.22
1860	31,443	35.58	2,665	24.09
1850	23,192	35.87	1,620	26.38
1840	17,069	32 67	554	28.44
1830	12,866	33.55	137	32.13
1820	9,633	33.07	No	(32.5)
1810	7,240	36.38	rec-	(36.0)
1800	5,308	35.10	ords.	(35.0)
1790	3,929	....	....	....

The last column of this table is deduced on the basis suggested in the last Census Bulletin, which seems to be not far from correct: that in any decade the births to emigrants arriving in that decade will just about balance the deaths and returns of emigrants, so that the gross total of arrivals will represent very closely the actual addition to the population due to the immigration of the decade, the remainder being the natural increase.

It should be noted also that the immigration records prior to 1840 were very defective, and could the true aggregates be known, would probably diminish very considerably the percentages shown in the lower part of the last column.

As the Census Bulletin well remarks: "If these figures were derived from correct data, they would be indeed disappointing;" but it proceeds to declare that they are "easily explained when the character of the data is understood," the whole difficulty being that the census of 1870 was "grossly defective in the Southern States." There is no doubt that it was so defective, but the question is, how defective? On this point then follows this amazingly careless and transparently unsound declaration, the italics being ours:

> There is, of course, no means of ascertaining *accurately* the extent of these omissions, *but in all probability they amounted to not less than* 1,500,000. There is *but little question* that the population of the United States in 1870 was *at least* 40,000,000, instead of 38,558,371. If this estimate of the extent of the omissions in 1870 be correct, the absolute increase between 1870 and 1880 was not far from 25 per cent. These figures compare much more reasonably with similar deductions from *the population in* 1880 *and* 1890.

Did it, or did it not, occur to the census authorities that it was quite as important to have "these figures" for 1870-'80 compare reasonably with the war decade of 1860-'70 as with the decade of 1880-'90, and that it would be as well to compare several decades instead of one only before venturing official statement of this kind? We presume not. We will now do this, however, and we shall find it to be wholly out of the question that there should have been any such error of omission as 1,500,000, and almost out of the question that the omission should have been so great as 1,000,000.

The uncorrected census figures are:

Population in *thousands.*	1840. 17,069	1850. 23,192	1860 31,443	1870. 38,558	1880. 50,156	1890. 62,481
Per cent. increase	32.67	35.87	35.58	22.63	30.08	24.57

If we assume the suggested 40,000,000 population for 1870, we obtain:

32.67 35.87 35.58 **27.21** **25.39** 24.57

In other words, while the percentages for 1880 and 1890 do compare pretty well, as ingenuously suggested, the favorable comparison is obtained only *by throwing into the war decade*, 1860-'70, *a larger ratio of increase than in the succeeding decade.*

Let us compare these same figures with immigration deducted, as above explained,* so as to eliminate the effect of that variable, but still using the census estimate of 40,000,000 for 1870. We then have for the percentage of natural increase only in the decade ending with each census:

	1840.	1850.	1860.	1870.	1880.	1890.
Per cent. natural incr.	28.44	26.38	24.09	**19.81**	**18.36**	14.11

Here the Census Bulletin's "favorable comparison" even with the decade 1880-90 disappears, and yet it is clear that the percentage of 1880 is much too small, and that for 1870 too large, because the former should certainly be larger than for the preceding war decade.

Let us now suppose the error of the 1870 census was only 1,000,000 instead of 1,500,000, we then obtain the following percentage of decennial increase:

	1840.	1850.	1860.	1870.	1880.	1890.
Per cent total incr.	32.67	35.87	35.58	**25.81**	**29.74**	24.57
Per cent natural incr	28.44	26.38	24.09	**18.40**	**19.68**	14.11

Here the percentages bear some sort of a natural relationship to each other, but even yet the indications are strong that the addition to the 1870 population is still too large, and should be somewhat under 1,000,000, rather than over, since there hardly seems enough difference to duly account for the effects of the war.

We may see this more clearly, moreover, in another way, which, as it forms the basis of the remainder of this article, we explain at length.

For the purposes of this investigation we have divided the country into the eight groups, used in Poor's Railroad Manual and our own Water-Works Manual, instead of into the five larger groups used by the census. These groups are:

1. *South Atlantic*
2. *South Central*
3. *Southwestern*

Including all the States south of the Potomac and Ohio Rivers, Iowa and Kansas, and including Colorado and Arizona; hereafter designated collectively the SOUTHERN BELT.

4. *New England*
5. *Middle*
6. *North Central*
7. *Northwestern*
8. *Pacific*

Constituting together what is hereafter called the NORTHERN BELT in distinction from the SOUTHERN BELT, as above described.

Now, as between these two grand divisions or belts, we have three broad facts:

1. All the census errors of 1870 are confined to the Southern belt. Doubtless all the censuses had errors, but none have been detected or are alleged, of moment, except as to the Southern belt in 1870.

2. Neither of these belts gains largely from the other by emigration, but, on the whole, the Southern belt loses rather than gains. There is much interchange of population, but, on the whole, the gains and losses are nearly equal, as interstate migration tends chiefly to follow isothermal lines.

3. Foreign emigration goes almost wholly to increase the population of the Northern belt. The part which goes south is nearly, if not quite, bal-

*This percentage of natural increase is obtained by dividing the *total* population at the beginning of a decade into the population at the end, less the immigration of the decade.

anced by the excess of southern emigration to the Northern belt.

Making these three broad assumptions, which, if they err slightly against one belt, err equally in favor of the other, we obtain the results to be shortly given. We first note the effect on the Southern belt only of the census estimate of the 1870 error, it being admitted that this error was wholly confined to the Southern belt:

Population in *thousands*:	1840.	1850.	1860.	1870.	1880.	1890
Census pop'n, S. belt.....	6,743	9,000	11,568	13,103	17,740	21,580
Per cent. increase.	27.56	33.47	28.53	13.27	35.39	21.65

Adopting the Census Bulletin estimate of 40,000,000 for the 1870 population, or 14,545,000 for the Southern belt only, we obtain these percentages:

Per cent. increase. 27.56 33.47 28.53 **25.73 21.97** 21.65

A plainly inadmissable result, unless population grew faster during the war than after it. Adopting our own allowance of 1,000,000 only as the error, we have:

Per cent. increase. 27.56 33.47 23.53 **21.91 25.79** 21.65

These figures afford cumulative and conclusive evidence that the error in the 1870 census is overstated by the Census Bulletin. Adopting the estimate of 1,000,000 for the 1870 error, which is the utmost that seems reasonable, we obtain the following table of the changes of population in the two great belts into which we have divided the country, to which should be premised that it bears rather hardly against the Northern belt, as compared with the Southern, in charging all the foreign emigration to it; but our immediate purpose is not sensibly affected thereby.

POPULATION AT EACH CENSUS OF THE NORTHERN AND SOUTHERN TIERS OF STATES.

Census of	Northern and Pacific Belt. Population 1 = 1,000	P. c. total incr'se.	Immigtion. 1 = 1,000	P. c. nat. in. only	Southern Belt Population 1 = 1,000	P. c. total incr'se
1890....	40,900	26.17	5,247	9.67	21,580	21.65
1880....	32,416	27.35	2,812	16.30	17,740	25.79
1870 ...	25,455	28.08	2,328	16 36	14,103*	21.91
1860....	19,875	40.04	2,665	21.27	11,568	28.53
1850....	14,192	37.44	1,620	21.75	9,000	33.47
1840....	10,326	36.23	554	28.54	6,743	27.56
1830....	7,580	33.87	137	31.46	5,286	33.08
1820....	5,662	38.06	No	33.66	3,974	32.22
1810....	4,236	36.38	rec-	36.38	3,004	35.47
1800....	3,106	32.34	ords.	32.34	2,202	39.10
1790....	2,347	.....	.....	.....	1,582	.....

* The reported census population is 13,103,000, to which 1,000,000 is added, as above determined.

Now, considering first the Southern belt, it is perfectly true, as the Census Bulletin remarks, that "the general law governing the increase of population is, that when not disturbed by extraneous causes, such as wars, pestilences, immigration, etc., increase of population goes on at a continually diminishing rate." It is not true, however, that it goes on at a sharply diminishing rate, especially over a whole continent at once, and in the face of a period of great prosperity following one of much adversity. It is therefore highly desirable to have the records of several preceding decades to see how strong this tendency to gradual decrease in rate of growth has been, in the face of results so apparently astounding.

Studying the last column of the above table, there is a distinct tendency of this kind visible during the period ending with the war decade, the decrease being from about 33* to about 28 per cent. The growth shown in the war decade is almost certainly too large; 20 per cent. increase instead of 21.9, would give 13,880,000 in place of the census, 13,103,000 (an addition of 777,000 instead of 1,000,000), and this would make the percentage in the 1870–80 decade 27.81 instead of 25.79 per cent.

This makes the 1870–80 decade fall reasonably into the long-continued series of *gradual but slow* decrease in rate of growth. Is it at all likely that there has now been a sudden and sharp decrease in rate of southern growth, in the face of the known activity and large emigration to that belt, which is now occurring for the first time in its history? If we assume a percentage of 25.0 in place of 21.65 for the 1880–90 growth, making no allowance for other than natural increase, it is the very least which history and analogy warrants.

Now, as to the northern belt, inasmuch as we have allowed the southern increase to be all natural, it is fair as respects the total (although not quite fair as between the two sections) to charge the whole immigration to the northern belt. Doing this, we have the amazing contrast shown in the fifth column of the above table. The apparent rate of natural increase under these assumptions fell off during the seven decades before the war from about 33 to about 22 per cent.; fell sharply during the war to 16¼ per cent., *still fell in the next decade*, instead of recovering, and is now rapidly becoming a vanishing quantity, only 9.67 per cent. This latter figure does not appear at all in the Census Bulletin, which admits a fall of "not far from 14 per cent." only; but this is because the Census Bulletin neglects the fact that the immigration goes almost wholly to the northern belt. The 14 per cent. calculation, for a single decade only, is the only one made as to natural increase, and to it is added the disingenuous (or singularly careless) remark: "Similar calculations for the population in 1880 and the decade preceding would, *of course, be valueless* (italics ours) on account of the imperfections of the census of 1870."

We have made shift to eliminate these imperfections in various ways in the computations first given above, however, and the result will hardly be claimed to be "valueless," since under any assumptions, and considering only the totals for the whole country, the contrast which the Census Bulletin so lightly declines to make is a startling one indeed.

We hold that the fifth column of the table last given contains all but certain internal evidence that the true ratio of natural increase in the northern belt, apart from all immigration, must have been at least 15 per cent. in the last decade, and probably more. If so, we should obtain the following estimate of the population of the United States in 1890:

Population in northern belt in 1880.....	32,416,000	
Natural increase at 15%.....	4,862,400	
Immigration in decade.....	5,246,613	42,525,013
Population southern belt in 1880.....	17,740,000	
Natural and immgr. increase at 25% ...	4,435.000	22,175,000
Total U. S. population indicated for 1890.....		64,700,013

Considering the figures for the entire United States given in the first table above, there is certainly clear indication that the rate of natural increase in the last column cannot have been less than 20 per cent., to which immigration is to be added. On this basis we obtain the following estimate:

U. S. population by census of 1880.....	50,155,783
Natural increase at 20%.....	10,031,257
Immigration in decade...	5,246,613
Total U. S. population indicated for 1890.....	65,433,653

The only alternative to the acceptance of these estimates as substantially right, and the census as 2½ to 3 millions short, is as we have stated, to believe that a social change of profound and far reaching importance has *suddenly* taken place in this country, of a magnitude which the Census Bulletin which purports to discuss it is far better adapted to conceal than to reveal. As nearly as we can judge from details, which we cannot go into, the errors are largely in the trans-Mississippi district. The proven fact that the census of New York and several other cities, and of one entire State, was exceedingly defective, will intensify the distrust which these figures are likely to create, and will lead, we trust, to the ordering of another census in 1895, and quinquennially thereafter, and to a census law which shall make capacity and not political belief the first essential for appointment.

* The censuses for the earlier decades were doubtless somewhat defective and increasingly accurate, making the apparent growth in the earlier decades abnormal.

CORRESPONDENCE.

Watches as Compasses.

LIMA, O., Oct. 25, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the future of the 24-hour system, where the hour hand revolves once in 24 hours, point the hour hand to the sun and XII. will always be toward the South (in the northern hemisphere). S.

The Sand-Blast for Cleaning Car Wheels.

BUFFALO, N. Y., Oct. 29, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR.—I have just noticed an error in your article published Oct. 4 (p. 302) with regard to cleaning car wheels and the use of a device at our works for this purpose. There was a mistake made in printing the article in inserting the number of wheels as 20 which were being cleaned in 3½ hours; this should read 200, making a very material difference. The machine is a patented one, invented by us, and while we are willing to arrange under proper conditions for its use by other manufacturers, it is not one that could be put into use without our permission.

Yours truly, P. H. GRIFFIN,
President N. Y. Car Wheel Works.

[The error referred to occurred in but a few copies of the edition and was due to one of the types being drawn out by the inking rollers while printing.—ED. ENG. NEWS.]

Bridge Failures and Bridge Lettings.

SAN FRANCISCO, Cal., Sept. 29, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: About twelve months ago a company commenced to build patent suspension bridges on the Pacific coast on a new and novel plan. It was claimed for the patent that it possessed all the elements conducive to cheapness and strength combined; in fact, to a bridge engineer those claims read like a fairy tale. They scoffed at such a mean capacity as 1,500 lbs. live load, and for the same price would not stoop to give anything less than 3,000 lbs. live load, even for country highway bridges having the lightest traffic.

Owing to the usually crude methods for awarding bridge contracts, and the persuasive ability of the representatives of the patent, the bridge found favor in the eyes of various boards of supervisors, commissioners and councilmen, notwithstanding the universal condemnation it received from the legitimate bridge engineers on the coast. Such condemnation was, of course, "all talk," "all theory" to those who could not comprehend it, and it was easily nonplused by the company offering to build a bridge on condition that the county paid for it if the bridge stood a satisfactory test. Notwithstanding the request of the county to take this bridge away after it was tried and found wanting, the company pluckily went on building and proposing to build bridges on the patent, and it is not less than a week ago that they were awarded the contract to build a bridge against nine or ten competitors, a number of them being well established bridge builders. As a sequel it is interesting to read the following dispatch from the San Francisco *Chronicle* of Sept. 28, 1890, relating to this patent:

SAN BERNARDINO, Sept. 27.—A suspension bridge with a 300-ft. span has recently been erected by the county over the Mojave River, near Victor, 50 ft. above the river. Complaint was lately made that the bridge was unsafe, and the county employed A. H. KOEBIG, a civil engineer, to examine the bridge, and he pronounced it unsafe.

The California Southern R. R. track ran along the side of the river under the bridge, and FRED PERRIS, the railroad chief engineer, notified the Board of Supervisors that the county would be held responsible for any damage done by the bridge. The board declined to accept the bridge unless the contractors would put it to a test and show it was capable of supporting the weight called for in the contract.

This morning the test was made in the presence of the board and many citizens. Eight mule teams hitched to two wagons loaded with ore were placed on the bridge. There were 10 men on the bridge at the time, when the structure went down with a crash, severely injuring two men. There is great indignation and excitement at Victor.

That the bridge fell is not a surprise—that it was fairly tested is; for how long have we seen bridges awarded and built which only require a test load to break them, and yet those bridges are standing to-day? Can we as citizens and taxpayers expect a better condition of things so long as we leave the awarding of contracts for bridges to men who know nothing about the article they are buying, and who consider it an unnecessary expense to get the opinion of somebody who does?

ALFRED D. OTTEWELL.

Another correspondent from Los Angeles, Cal., writes us about this same bridge, inclosing the same account of its fall, as follows:

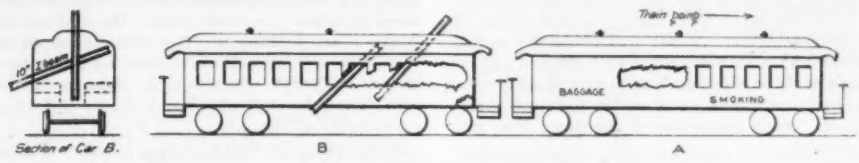
From what I have heard I am quite sure it is one of those telegraph wire structures, such as was inflicted on the County Commissioners at Richmond, Ind., last year, and which was reported upon by Prof. S. W. ROBINSON to have a capacity of about 5 lbs. per sq. ft. If the failure at San Bernardino was given larger circulation and publicity the legitimate bridge companies would be very seldom bothered with such competition. C. E. FOWLER.

An I-Beam Accident.

PROVIDENCE, R. I., Oct. 30, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I send you a sketch of the two passenger cars as they appeared shortly after the accident the night of Oct. 29 on the Worcester Division of the New York, Providence & Boston R. R., near Branch Ave. bridge. From some cause two flat cars of an incoming freight train telescoped, and two iron I-beams on the upper car must have swung over the track of the outgoing passenger train which just at this time was passing. One beam struck the smoking car, then cleared itself and entered the second car, where it lodged, partly sticking out



AN I-BEAM ACCIDENT.

through the roof. The other beam entered the second car, and cut a clean sweep, shearing posts and rods as though they were but pipe stems, and finally lodged as shown in the sketch. The accident occurred about 10 P. M.; 3 men were killed or fatally wounded and a few others hurt. The passenger cars did not leave the rails, and the track was cleared in a short time. E. W. R.

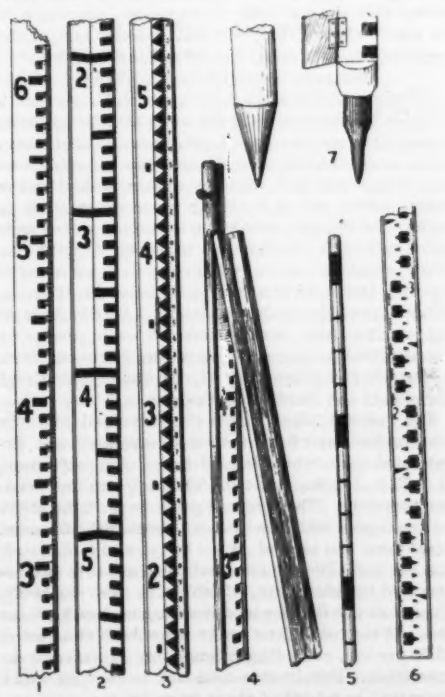
N. B.—On this division all trains take the left-hand track.

Stadia and Level Rods.

HONOLULU, H. J., June 5. 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The importance of all necessary aids to good stadia work, and the increasing interest in it, is my excuse for sending the inclosed illustrations, showing patterns of rods used in the Hawaiian Government Survey. I may say that they are entirely original, having been in use here from 10 to 12 years. The only sight reading rods



Hawaiian Government Leveling and Stadia Rods.

here, previous to the evolution of these, were of the old-fashioned Kravatt telescoping pattern.

No. 1 is a combined leveling and stadia rod. The advantage claimed for this pattern is the combination of visibility at a distance, by the use of the blocks which cover .05 of a foot each, with perfect accuracy on close range work, by the points on the edge. Tops of all black blocks are tens and tops of white spaces fives; black points are even and white points odd. The five-hundredths block can be divided to single hundredths by the eye with almost absolute certainty. The small figures, which are in red, are for such short range that the even foot cannot be seen. All else is in black, there being always white at the side to show plainly behind the cross hairs of the telescope. The hinge joint with brace is from the Honolulu Iron Works, showing in Fig. 4, which also has a raised rim to protect the graduation.

Rods Nos. 2 and 3 are stadia rods. Each is a round white ash pole, 2 ins. diameter, split lengthwise, and the two halves hinged together, the flat faces making together the face of the rod, 4 ins. wide. For carrying, the whole folds into a round pole, protecting the graduation from wear and tear, and being well fitted for rough work and unskilled help. The lower end is fitted with a shoe as shown in Fig. 7. Where the surveyor has raw help he can leave the rod set in the ground properly vertical, and sight back for distance from the next station. For leveling purposes the point or shoe can be left off. The double taper, or concave taper, of the shoe is a much better form for transit poles than the ordinary straight or conical shoe shown beside it. Our pattern of transit poles is seen in No. 5, of ⅝ white ash; the black rings and bands indicating 2-10 spaces are often useful.

No. 6 is a new applicant for service, and the designer, E. D. BALDWIN, presents the accompanying sample of its performance in a bona fide test traverse.

Comparison of Steel Tape and Stadia Rod.

By Steel Tape.	By Stadia.	Error in 10,000.
740.1 ft.	738.5 ft.	22
489.5 "	489.8 "	6
499.5 "	500.3 "	16
399.6 "	400.6 "	25
277.6 "	277.3 "	10
378.0 "	378.8 "	20
309.5 "	309.6 "	3
323.3 "	323.8 "	15
390.0 "	396.2 "	5
850.0 "	850.5 "	6
2 9.7 "	269.2 "	17
383 3 "	383.5 "	5
473.9 "	473 7 "	4
594.6 "	595.2 "	10
1,149.6 "	1,149.5 "	By two sights 546 + 603.5.
1,073 3 "	1,073.2 "	" " " 638 + 435.2.
456.2 "	455.7 "	10
227.7 "	227.5 "	10

Hoping I have not trespassed on space or patience.

CURTIS. J. LYONS,
Asst. Govt. Surveyor.

Notes and Queries.

R. S. P. writes: I see from the Atlanta papers that there is a demand for American railroad men in the Australian colonies. Do you know any of the particulars? Is there an opening for engineers (civil) and for contractors? Could you tell me where to apply for full information on the subject?

We know of no special demand there of any such kind as our correspondent has heard of; and if there was, it can hardly be one worth following up unless the opportunity comes to one unsought. There are many more and better chances here than in Australia for the man who is simply looking around for chances. If a demand comes from there for a special man to do some specific thing, it is a different matter.

B. R. G., of Georgia, asks us to give the five first naval powers of the world, "giving number of vessels, etc." This is a question difficult to answer from available data, as it is not the number, but the tonnage, armor protection and power of the guns of a battleship that count in effective service. Taking battleships in service and building on Jan. 1, 1889, as a standard we would give the list as follows: England, 42; France, 31; Italy, 26; Russia, 39 "ironclads;" Germany, 27 "ironclad ships and gunboats." Italy, for the number of ships, has one of the most powerful navies in the world, as 12 of her armorclad battleships have an aggregate tonnage of 94,313, or nearly 8,000 tons each. The largest of these ships, the *Italia* and *Lepanto*, each *to* carry four 100-ton guns and a broadside battery of seven 6-in. guns in one and nine 6-in. guns in the other. Our correspondent will see from the above that it is difficult to answer his questions fully in the space here at our disposal.

COMPARATIVE RESISTANCE OF SQUARE AND ROUND DRIFT BOLTS. Mr. JOHN B. TSCHARNER, Manager of the Kansas Water and Light Co., of Lawrence, Kan., answers our correspondent's query of Nov. 1 by referring him to an article written by Mr. TSCHARNER and published in the "Selected Papers" No. 4, of the Civil Engineers' Club of the University of Illinois. This paper is illustrated by diagrams, but it refers to round bolts only, and the relative holding power of pine and oak, with the bolt driven parallel or perpendicular to the grain. It is an interesting and valuable contribution on the behavior of 1-in. round rods and 1-in. round drift bolts. In yellow pine, 1-in. round rods, driven in a 15-16 in. hole from 3 to 12 ins., perpendicular to the grain, required an average force of 415 lbs. per lineal inch of depth, to withdraw it. The holding power of white oak was a little over three times that of yellow pine under similar conditions. The ratio of holding power, in pine or oak, of bolts driven perpendicular or parallel to the grain is about as 1 to 2.

The British and German Metallurgists in the South.

(*Continued from page* 394.)

THE DAY IN MIDDLESBOROUGH.

The wisdom of the committee which planned the tour for the foreigners has been well shown in the different nature of the places visited. Each city or locality visited has been quite different from any that have preceded. Of none is this more true than of the city which the excursionists reached on Tuesday, Oct. 21. The American towns which spring up in a night are famous; but hardly any American town has combined so rapid a growth with so substantial a development as has Middlesborough. In May, 1889, the total population of Middlesborough was 50. In August, 1890, it was about 6,200. Certainly the sights which greeted the visitors as the train rolled into town were full of novelty. One vacant lot bore a large sign, "Site of casket factory." Other lots bore like prophetic legends concerning the future industries to arise upon them. On the right was noticed the partly finished blast furnace plant of the Watts Steel & Iron Co. Farther into the town buildings of the most varying classes came into view. About one-third of the population of Middlesborough still dwell in tents, but buildings of every sort, from the "portable house" to stone and brick blocks of several stories, have been and are being erected. From the Pullman trains the visitors were escorted by the local committee to a street railway train, which was drawn to the hotel by a Shay locomotive over an extremely rough track. The streets of Middlesborough are now in process of construction.

After the excursionists had got comfortably warmed, inside and out, parties were made up for the different excursions arranged by the Middlesborough Reception Committee. About one-third of the excursionists chose the trip to Cumberland Gap Park and Solomon's Cave, and they were taken there over the Knoxville, Cumberland Gap & Louisville R. R., through the Cumberland Gap tunnel, three-fourths of a mile in length. The cave has a certain fascination in being of unknown dimensions as regards length. The guides said it had been explored for 9 miles from the entrance, and the end had not been found.

Another party was taken in carriages up "The Pinnacle," a high summit beyond Cumberland Gap, passing on the way many of the old earthworks which were built during the war to defend this pass. The prospect from the summit is of an almost unbroken forest, covering a wild and rugged country, mountains great and small rising in every direction. Peaks 150 miles distant were said to be visible on a clear day, a statement which seemed to bear a family resemblance to some others heard in various parts of the South.

A third party went over the Middlesborough Belt Ry. to visit the mines of coking coal up the valley of Bennett's Fork. A spur from the main line runs up the valley, which is narrow and winding, leaving barely room for the railway beside the stream. The coal seam has been entered in two places at an elevation of about 200 ft. above the railway, and drifts have been run in 500 to 600 ft. The coal will be slid in a chute from the drift opening directly down the side of the mountain, and will fall in a car at the foot of the slope. Mining is to begin as soon as the coke ovens now under construction are completed. A pile of coke made in an experimental oven was exhibited to the visitors, and the following was said to be a fair analysis: Water and volatile matter, 1.30%; carbon, 91.80%; ash, 6.70%; sulphur, 0.68%; phosphorus, 0.016%. The coal from the bottom bench is claimed to have as low as 1.60% of ash. The mines are under a three-year contract to furnish 300 tons of coke per day, at $2 per ton, to the furnaces of the Watts Steel & Iron Syndicate at Middlesborough.

The coal seams lie nearly horizontal and the one now opened is about 5 ft. in thickness. A rather novel feature of this excursion was the fact that a squad of a dozen soldiers accompanied the party to guard against possible lawlessness on the part of the natives of these mountain fastnesses. These people do not welcome the inroads which civilization is making upon their haunts; and various lawless acts are laid to their charge. The guide stated, however, that the natives had about exterminated themselves through their fatal feuds, and he seemed to

be not at all sorry. The German visitors were greatly amused at their first sight of an American military force, for the soldiers were boys in their teens and their discipline—or lack of discipline—was quite at variance with German ideas of military conduct.

On the return trip the party examined an exhibition train, loaded with specimens of timber, ores and minerals, taken from lands owned by the American Association, the company which has created Middlesborough. This train is to be run to the principal Eastern cities.

Those of the excursionists who did not join either of the three preceding parties went about the city to see what a 16 months old town could boast of. The only large enterprise really established as yet is the Watts Steel & Iron Syndicate, which has three large and well-built blast furnaces well toward completion, and proposes to erect a plant of open hearth basic furnaces with a daily capacity of 700 tons. It is claimed that from the ores in the vicinity of Middlesborough a pig iron can be made well suited for the basic process. A fire brick plant has also been erected by the Watts Co.

Among the industries said to be "secured" are a charcoal furnace for making car wheel iron, which is to be put up by Mr. O. W. DAVIS, of the Katahin, Me., Iron Works; the plant of the South Boston Iron Works, which is to be removed to this point, and a number of brick works and wood working establishments. Besides the above, the American Association has leased several considerable tracts of its mineral lands to coal and iron operators.

On the successful establishment of industries like the preceding, the success of the youthful city will depend; but it is to be noted that these companies are few in number, compared with those organized for speculative purposes. There are five land companies, the value of whose holdings at last auction prices was nearly $5,000,000, seven building companies with $1,300,000 capital, and a half dozen or more loan companies.

The most astonishing thing, however, is the amount of money which is being lavished in building a city with most expensive appurtenances in this wilderness. There is a water-works company with a capital stock of $750,000; a sewerage company, $160,000; a street railway company, $250,000; a belt railway, $1,500,000; a cemetery company, $50,000; nine hotel companies and two club companies, total capital, $395,000; nor is this all on paper by any means. The plan for the drainage of the town includes the rectification of Yellow Creek, which runs through the center of the town. The streets are carried over it by iron bridges on heavy stone abutments. On the streets, too, money is being lavished, and it must be borne in mind that all these improvements are carried out under heavy expense compared with what would be necessary in an older city. All supplies, except lumber and stone, have to be brought in from the outside world at heavy expense, hence the cost of living is high. Wages are also high; carpenters get $5 per day, work about nine hours, and struck recently for $6. Away beyond and above all the other inflated prices, however, is the cost of real estate. On the very best authority it is stated that lots have been sold in Middlesborough recently at $1,000 per front foot. The conclusion is irresistible that sales at prices anywhere near this are merely fictitious, made and published to influence prices.

It is doubtful whether the foreigners saw anything on their whole trip more thoroughly novel than this booming American town. But to see Middlesborough to-day in the height of its prosperity, one is inevitably reminded of hundreds of other American cities in the West and South, which have had their days of booming, and have suffered from them afterward. One naturally inquires what is to support all this expenditure. In a few months there must come a lull in building operations. Men out of employment will no longer have money to spend so freely; the tide will turn then, and the fall in prices will probably be a sudden and heavy one.

It is quite true that there is good coal and good iron ore in the vicinity of Middlesborough; but even granting all that is claimed for these deposits, it is difficult to see wherein they are so much better than those at many other places in the South as to warrant the building of any such city as that upon which the projectors of Middlesborough are now at work, at least for many years to come.

The founders of Middlesborough are frank enough to acknowledge that the city's future depends on the coal and iron deposits in its vicinity. But only years of actual working can fully determine the absolute value of these deposits. The analysis of the coal and the coke made from it show a very good material, low in sulphur and in ash, and the iron ore also appears to be of fair quality; but the reply of Sir LOWTHIAN BELL, when he was told that the ore from a recently opened mine had a certain analysis, is appropriate here: "I like the analysis of the furnace."

As to quantity and ease of working, the coal seams at Middlesborough are certainly not superior and probably not equal to those in the Pocahontas district, 100 miles to the north and east; and the iron ore veins seem thin compared with those in some other sections. At the same time the composition and physical character of both the ore and the coal may perhaps prove such as to give them greater value than now appears and make Middlesborough among the most important of Southern iron producing centers.

To return to the excursionists. In the afternoon the whole party assembled at the Library and Exhibition Hall, a neat brick and stone building, just finished, all the lower story of which is devoted to a permanent exhibition of specimens, maps and charts, showing the forest and mineral wealth in the vicinity of Middlesborough. Here the visitors had the pleasure of listening to Prof. JOHN R. PROCTOR, late Geologist of Kentucky, who explained the map showing the iron deposits of the United States, prepared by Hon. ABRAM S. HEWITT, to accompany his presidential address at the New York meeting of the Institute of Mining Engineers. Brief remarks were also made by Sir JAS. KITSON and by ALEX. A. ARTHUR, Middlesborough's founder, who declared it was the proudest day of his life.

The evening was spent in making the run to Knoxville, over the Knoxville, Cumberland Gap & Louisville R. R.—a line built by the company which has created Middlesborough. A two-hour stop was made at Knoxville, but as it was late in the evening the citizens of that enterprising city contented themselves with distributing a neat souvenir through the trains.

BESSEMER ORE AT CRANBERRY.

All along the excursion there had been careful inquiry as to the percentage of phosphorus in the iron ore deposits, but only in one or two instances had any one ventured to claim for any ore deposit that it was suitable for the Bessemer process. The most reliable authorities had frankly acknowledged that the only Bessemer ore deposit in the South at present known was that at Cranberry, N. C. At Knoxville a small party was made up to visit this place while the main body of the excursionists went on to Pulaski, Va.

Cranberry is reached at present by a narrow gauge railway running from Johnson City, Tenn., on the main line of the East Tennessee, Virginia & Georgia, up into the mountains of Mitchell Co., N. C., a distance of 34 miles, over which distance the trains are expected to run in 3½ hours, according to the schedule. The region is, with the exception of the White Mountains perhaps, the wildest and most rugged of the whole Appalachian system. The railway winds along the narrow valley of the Watauga and Doe rivers and Wilson's Creek, and terminates near their head waters at an altitude of 3,250 ft. above sea level, having climbed a distance of about 1,600 ft. in the 32 miles from Johnson City.

The ore of the Cranberry vein is a black magnetite, not so rich in iron as the Lake Superior ores, but having a less percentage of phosphorus. By selecting it is claimed the output will yield 50% of metallic iron, and that at the run of the mine will yield as much as 42%. In phosphorus the ore varies from 0.07% to less than 0.01%, and is claimed to average between 0.01% and 0.02%. The ore is also low in silicon and has but a trace of sulphur. Coke pig iron made from Cranberry ore averages below 0.03% of phosphorus. As to the amount of the deposit, the body of ore now being worked at Cranberry is stated by Prof. PROCTOR to be 400 ft. across, 1,700 ft. in length, 400 ft. in height above the railway track and of an unknown depth. The ore is at present mined by tunneling; but as soon as the amount taken out is sufficient to justify it, the whole mass of ore will be stripped and the deposit will be worked as an open quarry.

The Cranberry ore has been worked in a small way since the beginning of the century, and operations even now are on a limited scale, a charcoal furnace turning out about 10 tons per day. The lack of cheap fuel has been the great obstacle to the development of the property; but with access to the West Virginia and Kentucky coke, which will be given by the completion of the Charleston, Cincinnati & Chicago R. R., great things are expected of this section. A furnace is now being erected at South Watauga, on the East Tennessee, Virginia & Georgia, and a railway is to be built two miles up the river to join the East Tennessee & Western North Carolina road. Over this route the Cranberry ore will come down hill all the way to the furnace, 32 miles. For a coke supply the builders of the furnace are looking to Big Stone Gap, 50 miles northwest, which will be reached by the main line of the Charleston, Cincinnati & Chicago next season. The coke will also come down hill or over easy grades all the way.

Nowhere in the world, say the backers of this enterprise, can Bessemer ore and high-grade coke be brought together so cheaply as at this point. It is claimed that the cost of transportation of these raw materials will be at least $5 less per ton of iron produced than at Pittsburg; and that Bessemer pig can be made at a cost of $13 per ton.

The principal coal seam at Big Stone Gap is said to be 5 to 11 ft. thick, and the coke made from it is claimed to analyze 94.37% carbon, 5.07% ash, and 0.834% sulphur, and to be equal in physical structure to the Pocahontas coke.

While the Cranberry mine is the only place, with one exception, where Bessemer ore has been taken out and worked, it is claimed that the deposit extends all through Mitchell Co., N. C., and into Johnson and Carter counties in Tennessee. A half dozen companies have already secured the lands which are supposed to contain the best part of the vein. Enough prospecting has been done to indicate at least a fair probability that the amount of Bessemer ore in this region is so great as to be practically inexhaustible; the good quality of the ore seems to be fairly well proven; and there seems, therefore, to be a good chance that this will become one of the greatest ore producing districts of the country.

PULASKI AND THE GOSSAN LEAD.

All along the Norfolk & Western R. R. the work of town building, or to speak more accurately, town booming is making rapid progress. About every town along the line has caught the infection and one sees streets and avenues neatly staked out in places where not a building great or small is in sight. At Pulaski, where the excursion trains were side-tracked on Wednesday morning, Oct. 22, the town seems to have made quite a substantial growth, and to have a more solid basis for its boom than most of these embryo cities. At the Pulaski zinc works there are 10 furnaces, each producing about 1,900 lbs. per day, obtaining their ore from mines about 7 miles distant, on the Cripple Creek division of the Norfolk & Western.

The Pulaski blast furnace was visited and the visitors had their first chance to examine the Pocahontas coke, which is used here. A new furnace, 17 × 75 ft. is being built at Pulaski by an independent company. The contract price is $179,000 above foundations, which will cost about $25,000 more. Limestone can be had close by at a cost of 35 to 40 cts. per ton. The ore used will be a mixture of limonite and Potsdam ore, which it is said can be delivered at the furnace at a working cost of $1.25 per ton. It is expected to make iron here at a cost of $9.50 per ton, excluding interest on capital and depreciation. Pocahontas coke will be used, on which there will be a haul of about 80 miles.

For the excursion to the gossan lead a special train was provided by the Norfolk & Western Ry. The route was up the Cripple Creek and North Carolina extensions of the Norfolk & Western system to the present terminus of the latter. The Cripple Creek region contains brown hematite and limarite ores which have long been mined to produce an excellent quality of charcoal iron. The ore has to be washed to separate the clay in which it is imbeded and all the rivers of the district wear a very muddy hue in consequence. Lead and zinc ores also occur in this district; and an ancient shot-tower, which is said to date back to the war of 1812, testifies to the fact that the former have long been worked.

Ivanhoe, where the North Carolina extension leaves the Cripple Creek division, is an ambitious

town, with a furnace and an abundance of well staked out streets. From Ivanhoe south the railway follows the narrow valleys of New River and a small tributary. Several 18° curves and one 20° curve are necessary to fit the road to the bends of the stream, and grades are used as steep as 3½ %. The excursion train was the first passenger train ever run over the road, and it was necessary to put links between the Janney couplers to prevent the car hoods from striking in rounding the sharp curves. A curious thing on this road not far above Ivanhoe is a natural deposit of broken stone ballast, running remarkably even in size, and of excellent quality. It is being used for ballasting all along the line.

The gossan ore is a weathered deposit of pyrites extending from northeast to southwest for a distance of about 20 miles. At the Great Outburst mine, which was visited by the excursionists, the vein is said to be 175 ft. wide, and the weathering extends to a depth of 25 to 70 ft. The dip of the ore conforms nearly to the slope of the hill, so that, with a little stripping, a great mass of ore will be ready to take out in open cut. The ore is claimed to analyze between 40% and 50% of iron, 16% of silica, 0.12% of phosphorus and a trace of sulphur. Much prospecting and shaft sinking was done years ago in searching for copper, which makes it possible to make quite positive statements concerning the character and extent of the deposit, now that its value as iron ore is understood. It is on this ore that the furnaces of southwestern Virginia expect to chiefly rely in the future, since it can be obtained more cheaply than the brown ores, which have been their chief reliance.

To develop this vein, the Norfolk & Western Railroad Co. have surveyed a line running along its course for 16 miles. The streams which cut through the low mountain range in which the deposit lies make it quite easy to get at the ore. Other deposits of the gossan occur further south whose value is as yet undetermined. They will be reached by the North Carolina extension.

THE POCAHONTAS COAL MINES.

The best coal mines which the visitors saw anywhere in the South were those at Pocahontas, Va., where the excursion trains halted on Thursday morning. Until the railway entered this region hardly a decade ago, bears and other wild game were the most numerous inhabitants; now the output of the mines and coke ovens of the district is second only to that of the Connellsville region. The mine at Pocahontas visited by the excursionists has an average daily output of 1,000 tons, and could ship twice as much if cars could be had to handle the product. The coal seam is 9 to 12 ft. thick, averaging about 10 ft. The lower 2 ft. is separated by a 2-in. parting of slate, and this is left undisturbed to avoid the risk of getting slate mixed with the coal for the coke ovens. The seam lies nearly horizontal and high above water level. It has been worked to a point a mile and a half from the opening. The workings are well ventilated by a 25-ft. Guibal fan. No machines are used in the mining and very little powder. The roof seldom requires timbering. The miners are paid 37½ cts. per ton and average about $3.00 per day. The lump coal is now sold at 95 cts. per ton on cars at the mine, and the run of the mine sells at 85 cts. Besides its use in making coke the Pocahontas seam makes an excellent steam coal, and is being used on the ocean steamers. The recent fast runs of the *Teutonic* were made on Pocahontas coal.

The coke ovens in operation in the Pocahontas coal field now number about 2,000 and most of the producers intend to make large additions to their plant. As the output of all these ovens and collieries has to be shipped over the single track line of the Norfolk & Western, it may well be believed that the capacity of this railway is being taxed to its utmost. Everywhere, however, the road is being put in shape to carry the heavy traffic. Plate girder and stone arch bridges are replacing the old wooden trusses, long sidings are being put in, and the permanent way is being put in first-class shape. The completion of the Ohio River extension will doubtless furnish a market for some of the coke output in Ohio. Both engineers and contractors have had rough work in pushing this line through the roughest part of West Virginia's wilderness, but the work is now going on more smoothly and rapidly.

The St. Clair Tunnel.*

WITH INSET.

II.

THE DESIGN OF THE SHIELDS.

In our first article on the St. Clair tunnel, in our issue of Oct. 4, we described the progress of the work from its first inception through the various stages of tedious preliminary work up to the time when the plan of excavating with shields was finally adopted. To guide in the design of the shield, Chief Engineer HOBSON endeavored to secure working drawings of the shields which have been used, but was finally obliged to proceed with no other guide than the small drawings in DRINKER'S "Tunneling" of the shield used in 1868 in excavating the second Thames tunnel, and of BEACH'S shield, used in building an experimental tunnel under lower Broadway, New York City.

The shield as designed by Mr. HOBSON resembles BEACH'S shield more than any other, but differs in many respects from any shield ever constructed. Upon the accompanying inset sheet will be found complete working drawings of the shield as actually constructed and used, with a perspective view reproduced direct from a photograph, showing the shield as it stood near the mouth of the pit at Sarnia before being lowered to its place.

As seen by the drawings, the shield consists of a cylindrical steel shell, 15 ft. 3 ins. in length and 21 ft. 6 ins. in external diameter, made of steel plates 1 in. thick. The plates were planed to size, and were 5 ft. 7$\frac{23}{32}$ ins. long and 4 ft. broad. Twelve of these sheets made one complete ring, and three of these rings with a narrower ring 3 ft. 3 ins. in axial length made up the shell. Butt joints were used for both the longitudinal and circumferential seams. The joints were made by riveting angle irons on the interior face of the plates at the edge and then riveting the angle irons together. This made a joint which would have been very weak to resist tensile strain, but to resist external compression and forces tending to deform the cylinder it was perhaps as strong an one as could have been devised. In order to leave room for the hydraulic rams and to leave room for placing the tunnel lining, however, the longitudinal joints of the rear ring were made with an inner and outer splice plate, the former 2 ft. 11¼ ins. long and ⅛ in. thick, the latter 4 ft. long and ⅝ in. thick, and each 1 ft. wide. These outer splice plates on the rear ring were the only projections on the external shell of the shield, all rivets being countersunk, so that the structure would slide through the clay with as little resistance as possible.

The front edge of the shell was planed to form a cutting edge having an angle of 20°. The detail of the rear edge is shown in Fig. *a* on the inset sheet. Two angle irons with legs of 3 ins. and 1¼ ins. were riveted around the inside of the shell at the rear, leaving a space of 2½ ins. between them. In this was inserted a rubber packing strip with a cross section 2 ins. square, extending around the whole circumference of the shield. This rubber packing strip was held in place by set screws as shown in Fig. *a*. Each ring of the cast iron lining of the tunnel was put in place by bolting to the ring last completed, which was done just in front of the rubber packing ring. There was thus a tight joint formed between the completed lining and the shield which prevented mud and water from working into the back of the shield. At the same time the elasticity of the packing relieved both the shield and the lining of any strains due to slight variations in the castings or to slight alterations in the direction of the shield.

The bulkhead in the shield was placed 4 ft. from the rear edge, at the first circumferential joint, and its edge was riveted between the angle irons of this joint, as shown in the drawings. It was made of ⅛-in. steel plate. To its rear face 7 horizontal and 3 vertical stiffeners were riveted, extending 9 ins. from the face. In the lower part of the bulkhead were two rectangular openings, each 6 ft. high and 4½ ft. wide, through which all the material excavated in front of the shield was passed. These openings could be closed by a sliding door suspended by a chain, as seen in the perspective view. These doors were for use only in case an inrush of water or quicksand in front of the shield should endanger the workmen. They were never closed, however, from the beginning of the work to the end.

The details of this door and of its frame in the bulkhead are shown on the inset sheet; and it will be seen that as much thought and labor were expended in the design of the door as if its frequent use had been expected. All around the frame of the door was a round rubber packing against which the door rested when it was shut, thus making it absolutely water-tight.

To admit the hydraulic rams used to force the shield ahead, 24 holes 13½ ins. in diameter were cut through the bulkhead near its circumference; and to compensate for this weakening a ring of strengthening plates ⅛ in. thick and 16 ins. wide was riveted to the bulkhead all around the circumference. To receive each ram two gusset plates were placed in front of the bulkhead and riveted to it and to the shell of the shield. These transmitted the thrust of the rams directly to the outer shells, whose friction against the clay was the main resistance to the movement of the shield. The tail of the cylinder of the hydraulic jack was fitted in a ring, bolted between the gusset plates as shown in Fig. *b*. The head of the cylinder was flanged and rested against the bulkhead. An annular cover bolted over this head held the ram in place and took the thrust when the ram was reversed to draw back the heads and leave room for placing a new ring of the lining. This may be seen in the perspective view. The drawings and description of the hydraulic rams and their connections will be given in a succeeding issue.

In the portion of the cylinder in front of the bulkhead, three vertical and two horizontal partitions were built to strengthen the shell against deformation, the latter serving also as working platforms for the men engaged in excavating. The rear of both horizontal and vertical partitions was 4 ft. in front of the bulkhead, thus leaving plenty of room for the men at the working face to throw down the excavated clay in front of the bulkhead openings. At the front of the shield the horizontal partitions extended to the cutting edge of the shield. The vertical partitions were sloped back from the cutting edge as shown in the drawings. From the rear of the three vertical partitions flat tie rods, 7 ins. broad and ⅛ in. thick, extended back to the bulkhead and were solidly fastened thereto. These were intended to sustain the bulkhead against the pressure from the front which would have occurred in case of an inrush of water or quicksand. The bursting in of the bulkhead which closed the end of the preliminary drift, described in our first article on the St. Clair tunnel, had shown the need of strength in this regard.

In order to avoid the payment of the heavy tariff duties, it was desired to have the shield on the American side made in the United States, and that on the Canada side in Canada; but as the American company to whom the work was offered refused to undertake it, both shields were made by the Hamilton, Ont., Tool & Bridge Works. Of course, transportation of these immense cylinders, each of which weighed about 160,000 lbs., was out of the question. The plates and angles were punched and fitted at the shops, therefore, and the assembling was done at the site of the work.

To roll this ponderous cylinder from the site where it was built down the steep slope of the excavation was no light task. A cradle of wood was built to receive the shield at the bottom, and wooden skid-ways made of four lines of timbers 1 ft. square, spaced 4 ft. apart, were laid down the slope. Six heavy cables were then passed around the

* In our preceding article on the St. Clair Tunnel, Sir HENRY TYLER was wrongly given as the president of the St. Clair Tunnel Co. Sir JOSEPH HICKSON, general manager of the Grand Trunk Ry., is president of the St. Clair Tunnel Co. Additional data regarding the preliminary operations described in our preceding article have been kindly furnished by Mr. HOBSON, but reached us too late for insertion in connection with the original description. The work on the preliminary drift was begun in October, 1886. A shaft 14 ft. × 6 ft. was sunk on each bank of the river to a depth of about 85 ft., or 70 ft. below the surface of the river. The drift was pushed out 20 ft. on the American side and 186 ft. on the Canadian side. The drift was lined with 12-in. timbers cut in the form of voussoirs. The drifts were finally abandoned in July, 1887, after about nine months had been spent upon the work.

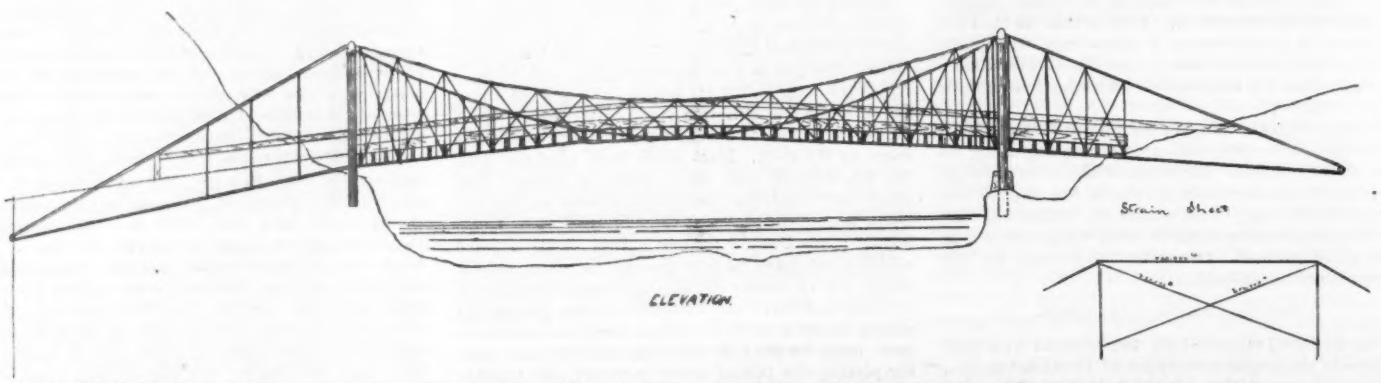
The unsuccessful attempt to start the full-size tunnel by means of shafts, described in our preceding article, was begun April 20, 1888. These were 23 ft. in diameter, lined with brick masonry. These shafts were abandoned as already described, when the Canadian shaft was down within 20 ft. of the tunnel level. In making the open cut excavation at the tunnel portal, which was the plan finally adopted for carrying on the work, progress was delayed on the Canadian side by a landslide which occurred July 28, and for this reason tunneling did not begin here until Sept. 24.

shield; one end was made fast and the other end was given a few turns around one of a row of piles driven at the end of the skid-ways. With a man at each rope to haul taut or ease up according to signal, the shield was rolled slowly down the slope and placed in the exact position desired in the cradle at the bottom. The time required for the operation was 80 minutes.

Wire Suspension Highway Bridges of Victor, Cal., and Elsewhere.

We have received a number of communications relating to the late failure at Victor, Cal., of a wire suspension highway bridge, built on the Eddy patent. From these letters and newspaper clippings we compile the following general history of this type of bridge, and send it out for the good it may do in deterring confiding but technically ignorant county commissioners from indulging in the costly and dangerous experiments of some of their Western brethren.

The cut given is a fac-simile of the plan and "strain sheet" of the bridge over the Mojave River, at Victor, Cal., as submitted to the Board of Supervisors of San Bernardino, Co., by the builders. We are indebted for the original "blue print" from which this is made to Mr. F. C. FINKLE, Chief Engineer and Superintendent of City Water-works of San Bernardino, and the only comment to be made on our cut is that by reduction it appears sharper and cleaner in its outlines than the original. Of its value as an engineering plan we leave our readers to judge.



A REDUCED FAC-SIMILE OF THE "PLAN AND STRAIN-SHEET" OF THE VICTOR BRIDGE, OVER THE MOJAVE RIVER, CAL.

(Failed under a test load of 120 lbs. per lin. ft.)

The history of this structure is as follows: The Supervisors of San Bernardino Co. advertised for bids accompanied by "plans, specifications, strain sheets and working details" for a highway bridge across the Mojave River at Victor. The span required was 300 ft. A number of bids were submitted, the lowest bid being by the San Francisco Bridge Co. for a Pratt truss of 300 ft. span, 1,250 lbs. live load per lineal foot, with a safety factor of 4. The next lowest bid was from Mr. C. A. SMITH, of Los Angeles, for a wire suspension bridge of the type known there as the "Eddy patent." The board rejected the Pratt truss and accepted the Eddy suspension as shown to them, with "detail and strain sheet" in the original of our cut.

Engineers pointed out to the board the defects in the accepted design, and at the request of the editor of the *Daily Courier* Mr. F. C. FINKLE gave his opinion in writing, calling attention to the vital defects. This report was published; but the bridge was being built and not until it was finished did the supervisors commence to doubt their own engineering advisors. When the work was done the supervisors hesitated to accept it, and finally appointed a disinterested engineer to examine and report upon it. This report was unfavorable, and agreed with the report of Mr. FINKLE previously published.

The contractor was still confident and so were *his* engineers, and they claimed that the bridge was capable of sustaining safely a live load of 1,250 lbs. per lineal foot. A time was set for a practical test, Sept. 27; and the result was that the abutment at one end came down, the vertical rods broke in many places, and one main cable parted. The breaking load consisted of 18 tons distributed over three wagons loaded with stone, six men and a six-mule team. The actual load that broke the bridge was only 120 lbs. per lineal foot of bridge. The wagons, men and mules fell 50 ft. to the river below; and two mules were killed and one man had his leg broken. These statements are made on the authority of Mr. F. C. FINKLE, before mentioned.

The sequel to this is, under date of Oct. 15, that the supervisors have declined to permit Mr. SMITH to rebuild the bridge and have ordered him to remove it within 15 days. The board will determine on a new site and a new plan for the Mojave bridge, at Victor.

The same type of bridge is being used elsewhere and the "cheap highway bridge" seems to be an especial favorite among Kansas County Commissioners. One of these "steel wire suspension bridges," of 100 ft. span, fell down recently, while in process of erection, near Rossville, Kan. The reason was plain, as the contract price, including abutments, was $1,000! A similar bridge in Osage County has had two mishaps, and there is a proposition now before the County of Topeka to vote $65,000 for building one of these bridges across the Kaw River at Topeka.

The Kaw at this point is 900 ft. wide, though it might be narrowed to 750 ft. as a minimum. As described, the bridge would be a steel wire suspension bridge of two spans, each 470 ft. long and a total length of 940 ft. The width would be 20 ft. center to center of cables. The roadway would be about 19 ft. wide, and two sidewalks extend 6 ft. out from the center of the main cables. As a bridge of these dimensions, at the price named, is an interesting subject for engineers and contractors, we have secured a copy of the specifications filed with the County Clerk of Shawnee County, Kan. These specifications are unsigned and the responsible engineers are not named, though the names are given of "consulting engineers" who, it is very safe to say, had nothing to do with these individual plans and specifications.

These "general specifications" are not long and we give them in full, as an interesting and fitting addendum to the plan and "strain sheet" of the Victor bridge shown:

GENERAL SPECIFICATIONS

for a suspension bridge to be built on Quincy street, over Kaw River, Topeka, Kan.

Foundations.—The foundations to consist of piles driven as deep as practicable, covered in with cement concrete. The foundations above extreme low water to be steel cylinders filled with concrete.

Towers.—The suspension towers to be composed of steel plates strongly riveted into cylinders, having a spreading base and filled with Portland cement concrete. They will be capped with iron and suitably decorated. The load will all be carried by the steel cylinders and not by the concrete filling.

Anchorage.—The anchorages consist of piles covered in with cement concrete; back of the piles is laid a large wrought iron pipe filled with railroad rails and Portland cement mortar around which the cables are fastened; the whole is then surrounded with a mass of cement concrete 36 ft. long, 20 ft. deep and 8 ft. thick; the adjacent earth then assists to hold this mass of concrete in place.

Dimensions.—The bridge consists of two spans of 470 ft. each from center to center of piers.

The roadway to be 20 ft. wide *c* to *c* of cables and the sidewalks to be 6 ft. wide from center of cable to outside of walk.

The towers are 60 ft. high above the roadway. There is 24 ft. in the clear above low water at the side towers, and 32 ft. in the clear at the center tower.

Steel Cables.—There are two main cables containing 1,500 No. 9 steel wires each, reaching from the anchorage on one side to the anchorage on the other. There are four auxiliary cables containing 200 No. 9 steel wires each, passing from one anchorage to the other, but crossing in pairs at the middle of each span. There are also two wind truss cables of 200 No. 9 wires each passing through the floor system of each span as shown on the plan, for the purpose of staying the bridge against wind pressure.

Stiffening Trusses.—There are two kinds of stiffening trusses: 1st. A system of vertical and diagonal steel wire ropes, connecting the main cables with the lower cables on which the floor system rests. 2d. Two wooden Howe trusses, 8 feet high from out to out, extending the entire length of the bridge. The effect of this will be to distribute concentrated loads over the whole span and make the bridge very stiff and rigid.

Floor System.—The floor system consists of cross timbers 3 ins. × 14 ins., placed 18 ins. apart under the roadway and 3 ft. apart under the sidewalks. The floor of the roadway consists of 2-in. plank laid diagonally crossing each other, the top course being oak. The floor of the sidewalk is 2-in. plank laid longitudinally. A felloe guard, consisting of a 6-in. × 6-in. stick lines each side of the roadway, and an iron hand-railing runs outside both sidewalks.

Loads.—The bridge is designed to carry 100 lbs. live load to the square foot over the entire roadway, and 50 lbs. live load per square foot of the sidewalks, with a factor of safety of 4.

Estimated Cost.—The estimated cost of the bridge is $65,000.

Since the above was in type the Kansas *State Journal* prints a letter from Messrs. JOHNSON and FLAD, of St. Louis, the consulting engineers mentioned, indorsing the principles of the Eddy patent suspension bridge. These gentlemen are well known and experienced engineers and their opinion on the engineering features of a bridge design are worthy of all credit; but what they say simply proves that the bridge engineer, rather than the bridge design, must be made the essential feature, if the blunders at Victor and the other places mentioned are to be avoided.

These gentlemen say truly that the "general specifications" would not serve as a basis for a contract, but that they were only intended as a general description of the design. They heartily indorse the wire suspension principle for highway bridges of long spans as cheaper than truss bridges, and say, "if properly stiffened and protected from rust" they are long lived. Their letter deals in detail with the novelties of the Eddy design, especially in the crossing of the auxiliary cables, and indorses these features as good engineering practice and as possessing marked advantages over other types in preventing distortion under unequal loads.

But both Mr. FLAD and Prof. JOHNSON strongly urge the absolute necessity of thoroughly competent engineering advice in the design and erection of these wire suspension bridges, and state that the anchorage will be increased in the final plan, and some other changes made. They themselves are under contract to prepare the detail plans and contract specifications, and there is no good reason to doubt, with their experience, the general fitness and safety of the resulting bridge.

The moral is that, if competent and conscientious engineers be employed in the design of highway

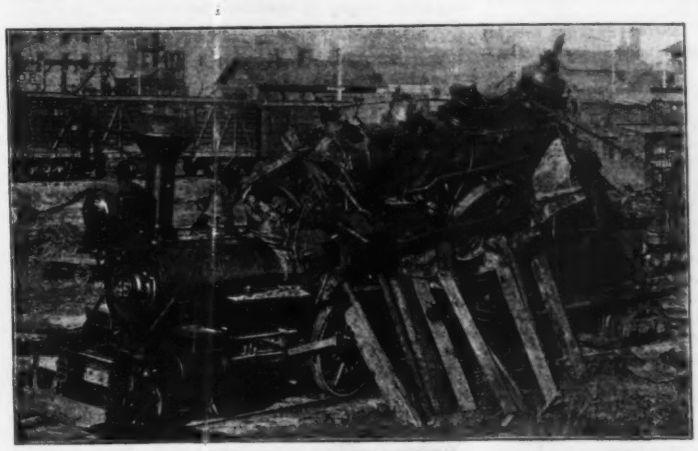
bridges of almost any type, the public can rest easy as to the results. But, unhappily, County Commissioners are not sufficiently impressed with the importance of this line of action, and so-called engineers will always stand ready to take advantage of the technical ignorance of the commissioners and impose upon them with *their* interpretations of a possibly good bridge design. This must have been the case at Victor, as no engineer having any reputation to lose would have been party to a plan such as we fac-simile; and the results have proved his incompetence and the original folly of the board of supervisors in accepting such a design. As long as county officials continue to make cheapness, and not intrinsic merit and intelligent engineering supervision, the standard of acceptance there will be no lack of bridge failures to detail.

A Curious Collision.

The accompanying view, for which we are indebted to the kindness of a subscriber who witnessed it, illustrates a curious collision which happened Oct. 30 on the Iowa Central R. R., near Marshalltown, Ia. A regular freight, headed by engine 52, which appears in the view, was going west

Diagram of Trains.

toward Marshalltown, with orders to "run regardless of all trains." In the meantime switch engine No. 45 was ordered "by a mistake in train orders" to start to back east some miles, with two empty flat cars, to bring back a load of stone. The two trains met in the position shown in the diagram, both running at a high rate of speed. Engine 52, after mashing the two flat cars into "jelly" and



A COLLISION ON THE IOWA CENTRAL R. R.

stuffing its own smoke box full of kindling in the curious way shown, made almost a clean jump over the tender of No. 45, knocking the tank loose, but otherwise injuring it very little, and loaded itself on the back of No. 45 in the position shown, in which position it was hauled back to the station, the lower engine and tender not having left the track. The coal in the tender took fire, however, and was burning fiercely when the two engines reached the station.

Both engine crews jumped just before the collision, but two of the men were rather seriously injured. The violence of the impact which could cause one engine to jump right over a tender in the way it did need hardly be noted.

This kind of accident, due to the incurable defects of the train dispatching system, is rapidly increasing in number with the growth of traffic. It is as certain as anything can be that no attempts to improve that system which do not substitute mechanism for human intelligence as the controlling cause can eliminate its defects, unless our weak and fallible human nature can be likewise made over. The only real remedy is the absolute block system, and to that system we must come at last, as they have already come in Great Britain.

Steel-Tired Wheels and the Principles to be Followed in Attaching the Tire to the Center.

At the last meeting of the Western Railway Club a paper on this subject was presented by G. W. RHODES, Superintendent of Motive Power of the Chicago, Burlington & Quincy R. R., which we condense as follows:

On the Chicago, Burlington & Quincy R. R., with 469 locomotives in service, from June 1, 1889, to June 1, 1890, there were 13 broken or cracked tires, the detail of which is given in the following table:

STATEMENT OF BROKEN DRIVING WHEEL TIRES ON LOCOMOTIVES OF C. B. & Q. R. R., FROM JUNE 1, '89, TO JUNE 1, '90.

	Kind of service.	Thickness when broken, ins.	Total mileage.
4-in. tires.	Pass.	2 10-16	163,173
	Switch.	1 21-32	150,536
	Freight.	2 13-16	194,886
	Switch.	1 27-32	103,723
	"	1⅛	107,900
	Freight.	2 17-32	208,898
	"	2 3-16	172,540
	"	2 5-16	192,426
	"	2 11-32	145,870
	Switch.	1⅛	178,029
3-in. tires.	"	1 13-22	261,967
	"	1 15-32	245,338
	Switch.	1 7-16	111,993

Mr. RHODES then exhibited etched sections from seven of the broken tires, showing that the fractures were due to flaws, "cold shuts" or "blow-holes" in the metal. He also showed sections from a tire which had failed while being turned in the lathe and from two which had been rejected because of surface imperfections, which were correctly surmised to indicate more serious interior defects. He then took up the methods of fastening tires to centers, substantially as follows:

Eight of the tires broke in the winter and spring months and five in the summer and fall. The first and third in the list were removed because of broken flanges and the remainder were broken through the tire. The broken tires were from three different makers. It will be noted that 6 tires failed above 2 ins. thick and 7 failed below 2 ins.

In this country the almost universal method of securing driving wheel tire to centers is to depend upon no other fastening than the shrinkage of the tire. It is a question however, whether with the increased speeds and weight, on drivers of recent engine construction a more secure fastening than merely shrinking on the tire should not be used. The practice on many lines is to make from 1¼ ins. to 1⅝ ins. the limit in thickness for the last turning of driving wheel tire. On some lines, with more recently constructed express engines, this limit is raised to 2 ins. As tires get thin, the blows they are subjected to in service sometimes results in a slight hammering out or enlargement, which causes the tire to become loose and slip. The initiative has already been taken by some of the Eastern lines in securing their driving wheel tires with retaining rings. If the breakage of the tire could be remedied by simply increasing the limit for thickness at last turning, the demand for better fastening would not be so apparent. The general experience is that tires are as liable to break when but half worn out as when more nearly reaching the limit at which they are allowed to run.

It is stated by some that with retaining rings it is practicable to get ⅛ in. more wear from a locomotive tire than if shrunk on by the ordinary method. A 3 in. flanged tire for a 62-in. centre will average 1,057 lbs. in weight; at 4¾c per lb. (old price) its value would be $50.21. For convenience in calculating, let us assume that it will be condemned at 2 ins. Two-thirds of the original weight would be 705 lbs., which at a scrap value of $19.20 per ton, would be worth $6.77

Cost of tire	$50.21
Deduct scrap value at 2 in. thick	6.77
	$43.44

The one inch that would be worn off, therefore, on the above basis, would cost $43.44, or $21.72 per half inch of wear. Any device which will enable railroads to get ⅛ in. more service out of its tire, they can afford to spend $21.72 for per tire without its costing any more than it may now be doing under the shrinkage plan, besides the advantage of greater security during the whole life of the tire. Assuming that a tire will give 10,000 miles to 1-16 in. wear, ⅛ in. wear would be equivalent to 80,000 additional miles before the tire has to be removed.

Now let us look at this subject in connection with the smaller truck wheels. It can hardly be allowed, if we omit consideration of the leading engine truck wheels, that a general introduction of steel-tired wheels in trucks is called for by the breakage of cast iron wheels. Especially is this apparent when we compare cast iron wheel breakage with locomotive tire breakage.

A few years ago 42-in. steel-tired wheels cost $80 each; at the present time some of the most promising steel-tired wheels of the same diameter can be had at a cost of $55 each. Without particularizing as to manufacture the latter figure may be detailed about as follows:

Wheel center, weight 415 lbs.	$35.00
Steel tire, weight 575 lbs., @2¾ cts.	15.81
Fastenings, labor fitting, etc.	4.19
Total	$55.00

The amount $4.19 is not an estimated one but is the actual cost of fastening, boring, turning and fitting the tire to 50 centers all labor included. We will doubtless be criticised for the price at which we have placed locomotive tire in an earlier part of this paper. These figures show that it by no means follows that $21.72 will have to be paid for a tire fastener. In our opinion, therefore, the real reason why the subject of steel-tired truck wheels is getting such general attention, is the lower prices at which they have been placed on the market and which has been brought about by the reduction in the cost of tires during the last year. If then any large number of steel-tired wheels are to get into service it will be well to consider carefully the principles that should be observed in attaching the tire to the center.

In Europe this subject has had much more attention than in this country and the variety of methods used at different times, we are almost tempted to assert, is only rivalled by the various forms of automatic couplers devised in this country.

It has already been asserted that the limit of thickness of tire, in so far as locomotive practice is concerned, secured to centers simply by shrinkage, is gauged not for fear of the tire breaking, but because of its tendency when thin to hammer out and slip. Precisely the same thing occurs with smaller wheels. We have here two bolts removed from a 42-in. wheel, the tire of which was shrunk on the center, and in addition secured by plates and bolts. You will observe close to the heads how the bolts have commenced to shear. You have all seen much worse samples than these, some one-half sheared off and some entirely sheared off—what has produced it? Unquestionably it is the slip of the tire. The Mansel retaining ring is perhaps one of the best known fasteners coming under this type. It has been used extensively abroad, and is generally well spoken of. In our opinion it is subject to the serious criticisms of bolt shearing. We have but few steel-tired wheels secured with this fastener on the C. B. & Q. R. R., but already the safety of one of our through passenger trains has been jeopardized through the failure of one of these wheels. The accident is described in the engineer's words: "Was running at a speed of about 48 miles an hour. It was the left front tender wheel that gave out, it at the time being upon the outside of a tolerably easy curve. All the bolts that pass through the retaining rings and the wheel was sheared off as though done by shears in a shop. The tire came completely off the wheel, going to the inside and falling upon the axle. This wheel was the only one to leave the track."

The wheel in question was comparatively a new one. Evidently the tire when applied did not have proper shrinkage. The brakes were used a great deal on this tank. Their constant application caused the tire to heat and slip which at once brought a shearing strain on the bolts, eventually cutting them off and resulting in the above accident.

Cases of bolt shearing doubtless occur more or less frequently, but for various reasons seldom come to the surface. The fact that many inventors herald their product as coming under the heading of "boltless wheels" shows clearly that what has been said on this feature of fastenings is well recognized by those who have made the subject a study. If it be granted then that in shrinking on tires of small diameter, as with those of large diameter, misfits may be made, and also that when worn thin even what was a perfect fit originally is liable to slip through the enlargement of the tire by hammering or by heating from brake application, it must be apparent that the best form of fastener is one which secures the tire to the center in a manner that will allow a slip of the tire without any shearing strain being brought on the fastener. In other words the fastener should be circumferential with the tire and not at right angles to it. Our belief is that this principle should be observed in locomotive driving wheels as well as in the truck or car wheels.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Lehigh & Hudson River.—This company has recently sold $500,000 of bonds. The proceeds are to be used in making new extensions and improvements.

Cape Breton.—This railway, running from Cape Breton to Sydney and North Sydney, N. S., 98 miles, has been opened for traffic.

Chicago & Eastern Illinois.—Arrangements are nearly completed for the construction of a line connecting this road with the Cleveland, Cincinnati, St. Louis & Chicago R. R.

Beech Creek.—Surveys are being made for an extension of this road from Clearfield, Pa., to Franklin, Pa., a distance of about 90 miles.

Phillips & Rangeley.—All but two miles of the grading on this railway from Phillips to Rangeley, Me., 27 miles, has been completed. Tracklaying is completed from Phillips to beyond Reddington.

Indiana Midland Railway.—The officials of this road are arranging for the right of way for an extension of the line to the coal fields of Clay County, over the roadbed of the abandoned north and south line which was surveyed through Brazil, Ind. It is proposed to begin tracklaying at once.

Louisville, New Albany & Chicago.—Since the decision of this company to extend its road to Evansville from French Lick Springs, a company is being organized and will file articles of association with the Secretary of State this week to construct a road from Columbus, Ind., to French Lick, making a through line to Evansville.

Projects and Surveys.

Dixfield, Weld & Phillips.—A project is on foot to build a railway from Dixfield, Me., on the proposed extension of the Rumford Falls & Buckfield R. R., via Carthage and Weld, to Phillips, Me., a distance of 22 miles. It is stated that a route can be secured affording easy grades and light work.

Augusta & Farmington.—An application has been made to the Maine State Legislature for a charter to build a railway from Augusta to Farmington, Me., a distance of 35 miles.

Ottawa, Arnprior & Parry Sound.—Engineers are now at work surveying this proposed Canadian railway. It is the intention of the company to erect elevators at Parry Sound and to establish a line of steamers between that port and Duluth, Milwaukee and Chicago. Work on the railway line will, it is stated, begin next spring.

Norristown, Bristol, Burlington & Lakewood.—This company proposes to build a railway from Norristown, Pa., to Lakewood, N. J.

Mohawk Valley & Northern.—Chartered in New York to build a railway from Poland to Noblesborough, N. Y. Among the incorporators are: David L. St. John, of New York City; C. F. Phillips, of Brooklyn, N. Y., and others.

SOUTHERN.—Existing Roads.

Stevenson, Sand Mt. & Dalton.—T. J. Lumpkin, of New England City, Ga., General Manager, writes as follows:

This road is projected to run from Bridgeport, Ala., to Higdon, Ala., and thence to Lathamville and Walnut Grove, Ala., with a branch from Stevenson to Higdon, Ala., a total distance of 92.5 miles. Surveys were commenced April 19 and completed Sept. 16, 1890. There will be a grade of 74 ft. per mile in ascending Sand Mountain, but for the remainder of the distance the grades will be light, and in no case will the maximum grade be continuous for more than ¼ of a mile. There will be no tunnels nor bridges of any size. All of the right of way has been secured, and considerable local aid in the shape of depot grounds and mineral lands obtained. The road will connect at Bridgeport with the Nashville, Chattanooga & St. Louis R. R., and at or near Walnut Grove with the Birmingham Mineral R. R. The principal traffic will be in cotton, coal, grain and lumber. Contracts will be let during January, 1891, and construction will begin as soon as possible thereafter. G. J. Hall, of Stevenson, Ala., is President, and R. A. Bowie, of Chattanooga, Tenn., is Chief Engineer.

Brewton Ry. & Manufacturing Co.—A correspondent writes us as follows:

This railway is 4½ miles long and runs from Brewton to Harold, Ala. It was built in the interest of the Harold Mill Co., for the purpose of transporting lumber from the company's mills to the Louisville & Nashville R. R. at Brewton, and to transact a general freight business. The road will not do a passenger business at present. The contract for construction was let in May, 1889, and tracklaying began Sept. 10, 1890. The road was opened for traffic Oct. 20, 1890. J. R. Crawford was Chief Engineer. The headquarters of the company are at Brewton.

Empire & Dublin.—R. S. Payne, of 89 Rawson St., Atlanta, Ga., Chief Engineer, writes as follows:

The western extension of this road is projected to run from Hawkinsville, Ga., via Grovania and Perry, to Fort Valley, Ga., a distance of 32 miles. Thirteen miles from Hawkinsville to Grovania have been located, and a construction force of about 100 men is now at work, 7 miles being already graded. The preliminary surveys have been completed to Fort Valley. The work on the first section will average about 6,000 cu. yds. per mile, and on the second division about 10,000 cu. yds. per mile; maximum grade 69 ft. per mile, and maximum curve 3°. All of the right of way has been obtained, and other aid has been obtained from Hawkinsville and Perry. The principal business of the road will be in lumber, turpentine and agricultural produce. The work is in charge of the Chief Engineer.

Macon & Atlantic.—The engineers are now surveying a second route for the eastern division of this road.

St. Louis, Alton & Terre Haute.—This company is rumored to have secured control of the Paducah, Tennessee & Alabama R. R., and will, it is stated, extend it to Birmingham, Ala.

French Broad Valley.—An official states that additional forces will be put at work and the line completed this winter.

Roanoke & Southern.—The contract for the grading, masonry and trestle work, from Roanoke, Va., south 8 miles, has been let to E. S. Moorman & Co., of Lynchburg, Va. Work has already been commenced with a force of about 200 men. The contract for the next 3 miles has been let to Elysian Bros., of Washington, D. C., and work will soon begin. Contracts for the remainder of the line will be let soon. It is reported that a branch will be built from Walnut Cove to Danbury, N. C.

Knoxville & Nashville.—This company is now nearly ready to commence work from Cookeville, Tenn., east to the Cumberland Plateau, 18 miles on the main line, and also on a branch from the latter point north to coal fields, 15 miles. The location is finished and the engineers are now cross-sectioning the line.

Projects and Surveys.

Charleston, Wilmington & Norfolk.—This company has been incorporated with a capital of $6,000,000. John C. McNaughton, is President, and the headquarters of the new company, for the present at least, will be at Charleston, S. C. A meeting of the company was held recently, and the purchase of the charters of the Mt. Pleasant, Santee & Little River R. R. Co., in South Carolina, and of the Portsmouth & South Mills R. R. Co., in Virginia, was authorized. These charters, with the company's own, give it the right to build between Norfolk, Va., and Charleston, S. C., 365 miles and branches. A contract was made with the Carolina Construction Co. to build the road, and work has been begun. The officers, in addition to Mr. McNaughton, President, are R. Duncan Harris, of New York, Vice-President and Treasurer; Carroll Foster, of Philadelphia, Secretary. The company will issue $3,000,000 of first mortgage bonds. The Carolina Land Co. has been organized by the same stockholders with a capital of $1,000,000, and the Carolina Construction Co. with a capital of $250,000. Of the railroad companies' capital, $500,000 has been subscribed.

Nashville & Mississippi Delta.—Surveys are in progress on this railway from Okolona to Houston, Miss.

NORTHWEST.—Existing Roads.

Winona & Southwestern.—Very satisfactory progress is being made in the construction of this railway. At the Winona end of the line the grading is completed to Stewartville, while at the other end 8 miles is graded northeast from Osage, Iowa., which is to be the terminus of the season's operations. The graders are at work all along the line between these points. Chief Engineer Wheeler is reported as saying that he does not think the tracklayers will experience any further impediment to their progress. They have now passed the Chatfield crossing, and by the middle of November will have reached Spring Valley. It is probable that Osage will be reached before New Years, and then regular passenger trains will be run.

Chicago, Milwaukee & St. Paul.—It is stated that ground is being secured at Champion for depot purposes and that next spring a line will be built from Champion to Ishpeming, Mich.

Centralia & Chester.—The grading between Centralia and Coulterville, Ill., is being pushed by a large force of men. Tracklaying will be commenced at Coulterville in about two weeks.

Burlington & Missouri River.—A press dispatch says:

It is reported that with the proceeds of an issue of bonds soon to be made by this company, the Black Hills branch of the road, now being graded west of Newcastle, Wyo., will be extended to Helena, Mont., making a connection at Billings with the main line of the Northern Pacific, and thence along the Musselshell River through the Castle Mining district. A Yellowstone Park branch is also among the probabilities.

It is proposed to grade about 100 miles of road beyond Merino, Wyo., this year on the extensions from near Cheyenne to a point about 50 miles south of Buffalo, in the northwestern part of the State. The rails will probably reach Merino before the close of the year. On the extension of the Grand Island & Wyoming Central through South Dakota, 44.5 miles of track has been put down since June between Edgemont and Custer, S. D. On the Grand Island & Northern Wyoming the track has reached a point 30 miles northwest from Newcastle.

Minneapolis, St. Paul & Sault Ste. Marie.—President Finney, of Chicago, is reported as stating that this road will probably be extended to Bismarck, 100 miles, next year. Also that a branch is projected from Napoleon, N. D., to Aberdeen. The Minnesota division extension into the Cheyenne Valley is the only extension to be made this season.

Duluth, South Shore & Atlantic.—It is now proposed to build 34 miles of road near Superior, Wis., to be used by this line instead of the Northern Pacific tracks for that distance, as is now done.

Projects and Surveys.

St. Louis, Collinsville & Carondelet Belt.—Surveys are to be commenced at once for this railway. E. G. Gerding, Collinsville, Ill.

SOUTHWEST.—Existing Roads.

Kansas City, Watkins & Gulf.—This road is now graded from Lake Charles to within 21 miles of Alexandria, La. All arrangements are completed for building the road to Alexandria, and it is expected to have 100 miles in operation by May 1, 1891.

Louisiana, Arkansas & Missouri.—The first 5 miles of this road from Tripp, Ark., south has been completed and put in operation. The road will run from Brinkley, Ark., to Alexandria, Va., when completed.

New Orleans & Northwestern.—It is stated that this company has decided to build north to Little Rock, Ark., and that preliminary surveys are in progress under direction of L. A. Dade. The road is now completed from Vidalia to Rayville, La., 74 miles. W. Dunbar Jenkins, of Natchez, Miss., is Chief Engineer.

Litchfield, Carrollton & Western.—Surveys are in progress for a branch from Columbiana, Ill., to Hannibal, Mo.

Missouri, Kansas & Texas.—An officer of this road is quoted as saying that this company would build 20 miles of road in Texas before Jan. 1, 1891, and that during next season the line from Sealey to Boggy Tank, Tex., would be completed.

Dallas, Pacific & Southwestern.—At a meeting of the officials recently held it was decided to resume work on the partly graded section from Dallas, Tex., northwest. W. J. Sherman, of Dallas, is Chief Engineer.

Corpus Christi & South American.—Griffin Bros., of Minneapolis, Minn., have the contract to build this road from Corpus Christi to Brownsville, Tex., 150 miles.

Atchison, Topeka & Sante Fe.—In a recent interview President Manvill is quoted as saying:

We have been credited with numerous purchases and works of extension of late. It has been said that we were negotiating for the Rio Grande Western, for the Denver & Rio Grande; that we were about to extend the Southern Kansas line from Panhandle, Tex., to Albuquerque, the Atlantic & Pacific further westward, and that we would build up the San Joaquin Valley to San Francisco. There is no foundation for any of these rumors. We are not building any new lines or extensions. The Frisco extension to Albuquerque will be carried out some day according to the original programme, but it may be many years hence.

Projects and Surveys.

Magnolia & Southern.—T. J. Elmore, of Magnolia, Ark., President, writes as follows:

The preliminary survey has been completed for this railway, which is to run from Magnolia to State line P. O., a distance of about 25 miles. Part of the right of way has been secured, and $80,000 in other local aid obtained. The principal business of the road will be in lumber, cotton and merchandise. Contracts will be let about January, 1891. It is expected that tracklaying will begin about July, 1891, and that the road will be opened for traffic by Sept. 1, 1891. E. Elmore is Chief Engineer.

New Iberia, Vermillion & Western.—Chartered in Louisiana to build a railway from New Iberia, La., to Vermillion River and beyond. The directors are: R. S. Perry, E. A. Sparr, Jas. A. Lee, Fred. L. Gates, Jas. Callahan, H. F. Lewis, and George Simon.

ROCKY MT. AND PACIFIC.—Existing Roads.

Atchison, Topeka & Santa Fe.—Press dispatches state that a large corps of engineers has been sent from Topeka, Kan., to locate the extension from Sapulpa, Ind. Ter., to Albuquerque, N. Mex.

Oregon Pacific.—At the request of the Farmers' Loan & Trust Co., of New York City, this railway has been placed in the hands of a receiver. The projected line of the Oregon Pacific R. R. extended from Yaquina Bay, Ore., to Boise City, Idaho, a distance of 600 miles. There was completed and in operation last May 140 miles, extending from Yaquina City to Coe, Ore.

San Francisco & North Pacific.—At the last monthly meeting of the directors the building of an extension north from Ukiah to Capello, Cal., 6 miles, and also an extension of the Guerneville Branch 2 miles into the red wood lumber section was considered.

Great Northern.—Tracklaying has begun on the extension from Fort Assinaboine, Mont., west.

Projects and Surveys.

Utah & Idaho.—The *Salt Lake Tribune* says: Local sentiment is growing in favor of the Utah & Idaho R. R. as an enterprise of the highest importance to Salt Lake's commercial interests. It will in a measure operate conjointly with the Deep Creek road for 65 miles out of Salt Lake City, turning north then to Idaho. As soon as the surveys and reports can be verified, the money can be secured from Eastern capitalists, and work started as speedily as possible. Organization will be perfected soon, when officers will be elected.

Colorado Fuel Co.—Surveys are being made for a railway by this company. The road will enter the coal fields located along the line of Glenwood Springs, Carbondale and Crested Butte.

Castle Valley.—A press dispatch from Salt Lake City Utah, says:

The new railroad which B. W. Driggs is pushing sout from Price, Utah, is to be known as the Castle Valley R

R. The capitalization has not been settled on, as the company is not yet incorporated, but the cost of construction and equipment will not be over $8,000 per mile. The line runs through a level country, so that the only grade to speak of lies through a 5-mile cañon, where the grade is 1½ per cent. The curves are too light for special consideration. The Castle Valley R. R. is graded for 20 miles, engineers are locating the grade for the other 20 miles and rights of way are being secured. There is timber within 10 miles and 25 miles, and ties are now being cut. The road taps a fine farming country and brings the San Rafael mining district, rich in gold and silver ores, within easy reach of the Salt Lake smelters. Not only will coal and iron be mined, but coke ovens will be erected, and mineral wax and asphaltum beds opened. Mr. Driggs goes east soon to place an order for rails, order locomotives and cars and float the bonds, so that operations can begin in early Spring.

Montana, Wyoming & Eastern.—This is the new name of the Montana & Wyoming R. R. noted some time ago. A meeting of the projectors will be held soon to consider the construction of the line.

FOREIGN.

Venezuela.—The Southwestern of Venezuela (Barquisimeto) Ry. Co. completed its tracklaying last month, and the other works are so far advanced that it is expected the line will soon be open for traffic. The road is owned by an English company.

Bolivia.—Mr. William Fith has submitted a proposal to the Bolivian Government, which has been sent to Congress, to build a railroad from Tacna to Aruro—Deputy Suago, of Bolivia, is vigorously supporting the proposal to construct a railroad to unite Bolivia and Peru, the road to run from La Paz round Lake Titicaca to Puno, the Peruvian Titicaca Lake terminus of the Mollendo and Arequipa Line.

CITY TRANSIT.

Electric Railways.—New lines or extensions are proposed between Middleboro and Brockton, Mass; at Petersburg, Va.; between Racine and Kenosha, Wis.; at San Antonio, Tex., by the Alamo Electric Street Ry.

Elmira, N. Y.—The Elmira & Horseheads Ry. has been granted permission by the State R. R. Commission to change its motive power on several lines from horses to electricity.

Plainfield, N. J.—The City Council voted on Nov. 3 to advertise for bids on the construction of about one mile of electric railway.

Wilkinsburg, Pa.—The Duquesne Traction Co. proposes building two lines between Pittsburg and this place It is hoped that cars will be running by Christmas.

Pittsburg, Pa.—The directors of the Pittsburg, Allegheny & Manchester Street Ry. are to adopt electricity as the motive power instead of horses. A vote on the question of issuing bonds will be taken in about 60 days. Address George B. Hill, Director.

Anniston, Ala.—J. H. Harris has petitioned the City Council for the privilege of building and operating an electrical railroad.

North Knoxville, Ky.—A bill is before the Council granting permission to the Knoxville Rapid Transit Co. to build a 4-mile electric railway to Lonsdale. The company must begin work within six months of the passage of the bill, and the line is to be finished within 18 months after the same date.

Covington, Ky.—The Covington, Cincinnati & Rosedale Electric Ry. has advertised for bids on the construction of the line.

Bloomington, Ill.—The Bloomington and normal lines have changed from the two to the single wire trolley system. The change was made by the Daft Co.

Waco, Tex.—The Waco Dummy Street Ry. will, it is said, increase its capital stock and change its motive power from steam to electricity.

Helena, Mont.—The Helena Electric Ry. has been authorized to use this power on all its lines.

Seattle, Wash.—The directors of the Metropolitan Street Ry. are contemplating an extension of their lines and the adoption of electricity, preferably the storage battery system.

Horse Railways.—New lines or extensions are proposed at Elizabeth, N. C., by W. Pailin; Palatka, Fla.; Charleston, S. C., by the Enterprise Ry.; Whiteboro, Tex., by J. M. Buchanan.

Pittsburg, Pa.—The Perry Street Railway Co. has been granted the right to lay a single track on several other streets. The Pleasant Valley Co. is to construct a line with T-rails. W. H. Graham can furnish information.

Sumter, S. C.—The Sumter City Railway & Freight Co. will, it is reported, soon begin the construction of a passenger and freight railway on all the leading streets in the city.

Albany, Ga.—Work will begin soon on the Artesian City R. R., and the construction of the Albany Street Ry. will be rapidly pushed.

Toronto, Ont.—Superintendent J. J. Franklin, of the Street Ry. Co., recently testified in court that the cost per car-mile of the horse railway service in that city was 10.9 cts. The useful life of a horse is about 6 years, and they travel some 15 miles per day.

Dummy Railway.—***Austin, Tex.***—George W. Brackenridge and others will build a dummy line to the site of the proposed dam in the Colorado River.

New Companies.—People's North Shore Street Ry., Chicago, Ill., capital stock $200,000; incorporators, A. Clark, B. F. Hill, H. F. Daly. West Brooklyn, N. Y., Electric Co., capital stock $50,000; incorporators, D. Hawley, C. Bellows, A. N. Spence and others. South Avenue Surface R. R., Poughkeepsie, N. Y., capital stock $18,000; incorporators, J. I. Platt, W. R. Ennis. S. W. Odell and others. South Side Rapid Transit Co., Austin, Tex.; capital stock, $100,000; incorporators, A. von Rosenberg, H. J. Doughty, W. M. Harris.

BRIDGES, TUNNELS AND CANALS.

Pittsburg, Pa.—Two sets of plans for the new Sixth St. bridge over the Allegheny River have been prepared: one by G. W. Ferris & Co., the other by Gustav Lindenthal, both of Pittsburg. The bridge will consist of two spans, supported by an abutment on either side and a pier in the middle of the river. The bridge company will probably soon decide upon which set of plans will be adopted. The estimated cost is $600,000.

Atlanta, Ga.—A project is on foot to build a bridge across Forsyth St.

Cleburne, Tex.—A bridge to cost $2,000 will be built across the West Buffalo River.

Canals.—Captain Marshall, of the U. S. Engineer Corps, who has been examining the projected Illinois and Mississippi Canal, in a special report upon the project has recommended that the work be commenced at the west end of the line and the war department has approved his recommendation. The first thing to be done is to construct the lock and dams at Rock River at the mouth. The probabilities are that it will take all of the $500,000 appropriated by Congress for the canal project to make the necessary survey, acquire the right of way and construct the Rock River lock and dams. Later on, if funds are available, another dam and feeder will be constructed at Dixon.

The Dominion Government has decided to expend $2,000,000 in constructing a new canal on the north side of the St. Lawrence at Coteau, Que., in order to overcome the Cedar Rapids. The present Beauharnois Canal, on the opposite side of the river, will be retained for water-power purposes. The new canal has been rendered necessary owing to the development of the St. Lawrence grain route from Chicago to the Canadian seaboard.

WATER-WORKS.

NEW ENGLAND.

Hardwick, Vt.—The Hardwick Aqueduct Co. has been incorporated.

Hartford, Vt.—An attempt to secure the incorporation of the Hartford Water Co. is being made and will probably be successful.

Portsmouth Navy Yard, N. H.—Congress voted $8,000 for the improvement of the navy yard. It is proposed to make the fort at the lower end of Seavey's Island into a reservoir.

Artic Center and Washington, R. I.—A supply for these villages and those lying between them will be, about Jan. 1, introduced from Carr's Pond in Coventry.

Westerly, R. I.—The fire district voted on Nov. 3 to buy the plant of the Westerly Water-Works Co., provided a satisfactory price can be agreed upon.

MIDDLE.

Landsowne, Pa.—The following is from J. C. Neibert:

An artesian well has been sunk and over 100 houses are already supplied. A stock company and an enlargement of the plant are under consideration. Casper Pennock is at the head of the enterprise.

Tremont, Pa.—The incorporators of the North Union Water Co. are: W. C. Mayer, Pittsburg; C. L. Doyle, Sewickley, and George B. Motheras, Allegheny. The capital stock is $50,000.

Millvale, Pa.—The Bennett Water Co. are constructing works. Address C. Van Buren or Fred Klussman for further information.

Pittsburgh, Pa.—The south side water supply has been considerably increased by the recent completion by the Monongahela Water Co., of the large distribution main, from the Highland Reservoir to Soho. From the reservoir to Fifth avenue this main is 30 ins. in diameter and from Fifth avenue to Soho 24 ins. in diameter.——An independent water supply system is being put in Carnegie, Phipps & Co. to supply their mills on Twenty-ninth street. The supply will be from dug wells, 40 ft. deep, located about 30 ft. from the river, and there will be three pumps.

SOUTHERN.

Buchanan, Va.—The following is from Jas. D. Weeks, Vice-President:

The Central Land Co. hope to let contracts soon for the construction of gravity works, taking their supply from springs 4 miles distant. The cost of the works complete is estimated at $100,000. The population is now about 1,000. J. H. Harlow, Pittsburg, Pa., is engineer for preliminary work.

Luray, Va.—Works are to be put in by the Valley Land & Improvement Co. President, D. F. Kagey; Secretary, T. E. McCorkle. Surveys for laying 8 miles of mains have been completed by Engineer Alexander Y. Lee, of Pittsburg, Pa.

Shenandoah, Va.—The following is from J. F. Wheelwright, secretary:

The Shenandoah Land & Improvement Co. intends to build works as soon as possible. Howard Murphy, Philadelphia, is making the plans.

Vinton, Va.—The works are being built by the Roanoke & Vinton Light & Water Co. and will be in operation by Jan. 31. Pumping is used.

Elkins, W. Va.—Works are still under consideration.

Sumter, S. C.—The New York Contract Co. will put in works. The supply will be from driven wells. The contract calls for 5 miles of mains and 50 hydrants at the start. The town will take $2,500 of the company's stock.

Dawson, Ga.—A correspondent informs us that contracts will soon be let and that W. B. Cheatham can give information.

Deblin, Ga.—From information given by A. H. McLaws editor of *The People*, it seems probable that works will be constructed soon. Private subscriptions to a considerable amount have been secured. It is proposed to secure a supply from artesian wells. Population, 2,000.

Ozark, Ala.—Works are talked of. William Garner is Mayor.

Shelby, Ala.—A resident informs us that works are being built by the Shelby Manufacturing & Improvement Co.

North and West Knoxville, Tenn.—Duncan S. McIntyre, Mattoon, Ill., and George W. Sturtevant are trying to secure the right to supply these towns with water. Both towns were formerly a part of Knoxville, and are supplied by the Knoxville Water Co. The proposed supply is from Tillery Springs, about three miles from North Knoxville, and the works are estimated to cost $100,000. The Mayor of North Knoxville, Aldermen W. O. White and W. E. Moses, constitute a committee to investigate the matter and submit an ordinance to the Board.

Harrodsburg, Ky.—W. K. Cardwell, Mayor, informs us that at the next meeting of the council action will be taken regarding works.

NORTH CENTRAL.

Harrison, O.—Bids will be received by H. O. Campbell, Village Clerk, until Dec. 2, 1890, for the construction of works to be owned by the city, and also on the basis of hydrant rentals, for the construction of works to be owned and operated by a company. The bids must be based upon supply wells, a 10 × 6 × 10-in. duplex pump, a 50 HP. boiler, 9,000 ft. of 8 and 6-in. pipe, 21 fire hydrants and a 500,000-gall. reservoir. J. A. Grant is Mayor.

Wellston, O.—Works to be owned by the town are being constructed.

St. Joseph, Mich.—There is still some talk of building works. Address F. Morelock.

Belleville, Ill.—The City Water Co. has contracted with the Cook Well Co., of St. Louis, Mo., for several wells.

NORTHWESTERN.

Beloit, Kan.—The following is from E. E. Stevens, Larned, Secretary of the Beloit Water Co.:

The Beloit Light and Water Co. has leased the works of the Beloit Water Co., and is now building an electric lighting plant to be run in connection with the water-works. The report that the works had reverted to the city was false.

SOUTHWESTERN.

Batesville, Ark.—The council has granted a franchise for water-works and electric lights.

Marianna, Ark.—The works are nearly completed.

Bastrop, Tex.—It is reported that a company will build works.

Flatonia, Tex.—The city has voted bonds for works.

Hempstead, Tex—A windmill will be used.

Longview, Tex.—Works are projected.

Yoakum, Tex.—It is reported that a contract has been let for works costing $55,000.

Del Norte, Col.—The following is from George D. Nickel, Engineer.

The town is constructing, without contractors, a $22,000 water-works system. The supply will be pumped from the Rio Grande River to a reservior. The works will probably be completed by Feb. 1. Population, 1,000.

PACIFIC.

Ballard, Wash.—J. McIntire proposes to purchase the works of the West Coast Improvement Co. at cost, about $11,000, and enlarge the same, putting in about 30 hydrants. He has applied to the town council for a franchise.

Centralia, Wash.—Construction is under way, and contracts for a pump and 6 miles of mains have been let.

Forest Grove, Ore.—The Gales Peak Water Co. has been incorporated with a capital of $100,000 by C. M. Keep, E. W. Hains and others to supply Forest Grove, Cornelius and Hillsborough, with its office at Forest Grove. The main supply will be from Prickett's Creek on Gales Peak, about 150 ft. above Forest Grove.

San Bernandino, Cal.—F. C. Finkle, City Engineer, informs us that the new work owned by the city, were tested Oct. 25.

Stockton, Cal.—The Stockton Water Co. has been incorporated by W. S. McMurty, of Los Gatos, D. S. Murphy, of San Jose, and others. Capital, $500,000. Works were built here in 1857, and are now owned by the Stockton Water-Works Co.

CANADA.

Toronto, Ont.—Two compound high duty pumping engines for the high service have recently been completed

by the Polson Iron Works Co., in conjunction with the Geo. F. Blake Co., of Boston, Mass., the latter firm supplying the water cylinders.

Winnipeg, Man.—An attempt is being made to secure money to extend the mains some 5 or 6 miles. A preferred issue of bonds has been proposed, but there seems to be difficulty in obtaining the permission of the present bondholders to pursue such a course.

ARTESIAN WELLS.

Ocala, Fla.—The Ocala Water-Works Co. has a well down over 500 ft., and will carry it further.

Mason City, Ia.—An artesian well is being sunk in connection with the water-works.

Chinook, Mont.—Work on the well is in progress at a depth of 1,800.

Sherman, Tex.—A well is being sunk in connection with the water-works.

IRRIGATION.

Pasco, Wash.—Pasco Irrigation District bonds to the amount of $130,000 have been sold at 90, and the commissioners have let the contract for a ditch 8 ft. wide, 3 ft. deep and about 20 miles long to John Shine, Chicago, for 12½ cents per cu. yd.

Delano, Cal.—The Poso Irrigation District, in northern Kern Co., will at once begin the construction of a canal about 25 miles long, a dam and several reservoirs.

SEWERAGE AND MUNICIPAL.

Sewers have been ordered at Johnstown and Rochester, N. Y., and Pittsburg, Pa.; further information can be obtained on application to the city authorities.

Southington, Conn.—T. H. McKenzie, C.E., writes us that it is possible that this town and Litchfield will dispose of their sewage by irrigation. Representatives of the towns have visited the irrigation farms at Cranston, R. I., and Framingham, Mass., with this object in view.

Newark, N. J.—The Sewer Committee of the Council has decided to report favorably on the construction of a number of sewers.

Columbia, S. C.—D. B. Miller is reported as preparing plans for a sewerage system.

Atlanta, Ga.—The City Council has under consideration ordinances for sewers costing $95,000.

Knoxville, Tenn.—R. F. Hartford, of Chattanooga, has completed plans of a sewerage system embracing 40 miles of sewers and drains for this city.

Streets.—*Providence, R. I.*—The specifications for the new concrete sidewalks call for a transverse fall toward the gutter of ¾-in. in the foot, sand or gravel filling, coarse sand and tar foundation 2 ins. thick after rolling and brought to a smooth surface by the addition of fine, tar-coated pebble, a 1-in. top dressing of sharp sand thoroughly saturated with tar and rolled.

Newark, N. J.—The City Council has ordered a large amount of granite, trap and asphalt paving.

Pittsburgh, Pa.—A large amount of asphalt block paving is proposed and will probably be laid.

Columbus, O.—The City Engineer has filed estimates for a considerable amount of asphalt, brick and stone pavements.

St. Paul, Minn.—The following statement of public improvement expenses from Jan. 1 to Nov. 1, has just been published: 8 miles grading, $54,754; 8 miles sewers, $74,537; ¼ mile paving, $15,500; 5 bridges, $135,383; work still in progress, 35 miles grading, $300,000; 15¾ miles sewers, $210,000; 1 mile paving, $30,000.

Denver, Col.—The Barber Asphalt Co.'s plant in this city is reported to have cost $50,000, and to be capable of producing 2,000 cu. yds. of asphalt a day. The company recently received a very large paving contract.

Bonds.—*Aransas Pass, Tex.*—The city has voted to issue $15,000 of street improvement bonds.

ELECTRICAL.

Electric Light.—New plants or extensions are proposed in the following places: Lispon, N. H.; Branford, Conn.; Buchanan, Va., address Central City Land Co.; Americus, Ga., address National Guaranty Co., Cordele, Ga.; Lakeland, Fla., address E. B. & L. Briggs; Galiatin Tenn.; Camden, Ark., address Camden Electric Light & Power Co.; Longview, Tex.; Seymour, Tex., Port Angeles, Wash., address L. Rockman.

Burlington, Vt.—The Burlington Woolen Co. has decided to add another 130 HP. water wheel to its plant for electric lighting purposes.

Pittsburg, Pa.—The Oakland Square Electric Light Co. has been incorporated, with a capital stock of $10,000, by E. C. Glodfrey, Thomas McGowan, J. A. Steel and others.

Washington, D. C.—The Board of Electric Control appointed last week by the President is required to report on the following subjects: First, there shall be recommendations for a complete system of subways, with all suitable branches, etc., accompanied by maps, details and estimates of cost. Next, opinions as to whether the subways should be built, owned and operated by private corporations or individuals, or constructed and maintained by public authority and leased; if the latter, the terms and conditions of such leases are to be provided. Also there will be recommendations concerning the construction, location, operation and maintenance of underground cables and current conductors, with a view to promoting the public safety and to secure the most convenient and efficient service. There shall be notes upon the restrictions that are to be imposed by law upon the character and intensity of the currents and also upon the arrangement and use of the authorized wires.

New Orleans, La.—An ordinance regulating the use of electric wires has been reported to the City Council. It calls for the insulation of all electric wires used with more than 10 volts potential, and makes the use of cut-offs compulsory on all entrances to buildings. No wire will be permitted to hang lower than 20 ft. above the ground. All arc lights must be provided with glass shades, and spark arresters on the top and bottom of the light. No wires will be allowed to cross the streets diagonally.

Memphis, Tenn.—The Brush Co. recently offered to furnish 2,000 c. p. lights at the following rates: $15 each for 50, $12 each for 75, $10 each for 100, and $9.50 each for 200, prices being for the month. A contract for 100 lights has been signed.

Santa Fe, N. M.—The Santa Fe Electric Light & Power Co. was recently incorporated, with $25,000 capital stock, by C. F. A. Fischer, T. B. Catron, and others.

Port Angeles, Wash.—The City Council is reported to have granted L. Rockman a franchise for building an electric light plant.

CONTRACTING.

Sewers.—*Brooklyn, N. Y.*—The following bids were recently opened:

Bidders.	20-in. brick, per ft.	24-in. pipe, per ft.	18-in. pipe, per ft.	15-in. pipe, per ft.	12 in. pipe, per ft.	Manholes, each.	Street basins, each.
Harris & Maguire	$4.50	$3.00	$2.35	$2.20	$1.75	$36	$110
P. Milne	4.00	3.00	2.00	1.75	1.25	35	100
E. Gorman	3.45	2.50	1.60	1.45	1.09	36	97
H. Bogert	3.15	2.35	1.60	1.35	1.03	34	98

Albany, N. Y.—The following bids were recently received for a 24-in. pipe sewer:

Bidders.	24-in. pipe, per ft.	Y branches, each.	Manholes, each.
J. J. Holler	$2.10	$7.85	$68
W. E. Murphy	2.30	9.00	60
J. Doyle	2.14	7.25	65

PROPOSALS OPEN.

Sewers.—*Brooklyn, N. Y.*—Two large contracts. John P. Adams, Nov. 11 and 14.

Suspension Bridge, N. Y.—See advertising columns.

Middletown, O.—For furnishing the material, labor, and constructing a brick and tile sewer, including all branches, Y's, T's, specials and service pipes, also for excavation and back-filling. Nov. 13, B. J. Niederlander.

Denver, Colo.—Sanitary sewer costing within $76,240. F. B. Crocker, Nov. 25.

Street Work.—*Brooklyn, N. Y.*—Grading and paving with cobblestone or Belgian block John P. Adams, Nov. 17.

New York City.—Crosswalks. T. F. Gilroy. Nov. 13.

Bridges.—*Hamilton Co., O.*—Three wrought-iron highway bridges. J. Hagerty, Auditor's Office, Hamilton Co., O.

Electric Light Plant.—*Harrison, O.*—Plant comprising 75 HP. boiler, 75 HP. engine, 30 arc light dynamo and 25 lights, 600 lamp incandescent dynamo. J. A. Graft. Dec. 2.

Water-Works Plant.—*Topeka, Kan.*—See advertising columns.

Filling and Piling Work.—*Chicago, Ill.*—In accordance with plans and specifications for filling and piling a portion of the lake front east of the Illinois Central Ry. for the World's Fair site. J. H. Kingwill, Asst. Secretary. Nov. 12.

Repairing and Extending Pier.—*New York City* Department of Docks. Nov. 19.

Draining.—*Elburn, Ill.*—Draining a lake in Kane Co. C. E. Morrill. Nov. 15.

MANUFACTURING AND TECHNICAL.

Rolling Stock.—Within the past month the Chicago & Eastern Illinois R. R. contracted for 2 complete Pullman vestibule trains, 4 baggage cars, 9 freight locomotives and 4,000 coal cars of 60,000 lbs. capacity.

The Wheelock Engine Co. Works recently completed at Worcester, Mass., although of several times the capacity of the old shops, have proved too small to accommodate the rapidly growing business in the new designs of the Wheelock engine, although the shops are now run night and day. Extensive additions to the existing facilities will be at once made.

The Pullman Co.—The last annual report of the President gives the following interesting statement of the work done during the fiscal year: There have been built and placed in service during the year 101 sleeping, parlor, dining, special and tourist cars, costing $1,365,503.40, or an average of $13,519.83 per car. Orders have been placed at the company's works for 119 Pullman cars, the estimated cost being about $16,500 each, or an aggregate of $1,963,500. The number of cars employed in the service is 2,135 of which 1,849 are standard, and 208 tourists, or second-class cars. The number of passengers carried during the year was 5,023,057; the number of miles run, 177,033,116. During the previous year the number of passengers carried was 4,242,512, the number of miles run, 144,842,618. The year just ended shows, therefore, an increase of a little over 18 per cent., both in the number of passengers carried and miles run. But a still more important demonstration of the value of the vestibule patent has been by actual test in serious railway accidents, several of which have occurred to these trains since their operation began. Collisions have happened, at a speed of 40 miles an hour, as appears by evidence in the litigation, without injury to passengers.

Byram & Co., Detroit, Mich., have recently received orders for 17 Colliau cupola furnaces having a daily melting capacity of 664 tons.

J. P. Witherow & Co., New Castle, Pa., is reported to have closed a contract for a $450,000 steel plant at Middlesborough, Ky.

The Hughes Steam Pump Co., Cleveland, O., have recently erected new shops in order to accommodate their greatly increased business in all kinds of water-works machinery. The new office is at the corner of Coe and Hamilton Sts.

The Thurmond Car Coupler has recently been adopted by the Cape Fear & Yadkin Valley Ry. as its standard freight car coupler, and by the Atlanta & West Point R. R., which already has 300 cars equipped with it.

The Morison Allen Co., of New York, have been awarded the contracts for the erection of the Jewell filtering plants at Hurly, Wis., 1,000,000 galls. per day, and Ironwood, Mich., 1,500,000 galls. per day.

The Schiffler Bridge Works, of Cleveland, O., are now constructing a large bridge over the Coosa River in Alabama, one over the Mississippi River, and a 4-span viaduct for the Memphis & Western R. R. They are also furnishing the structural iron for the new elevated railroad at New Albany, Ind. The Marble Creek viaduct, in Kentucky, has recently been completed by this company. It is 770 ft. long, and 220 ft. high.

The Keystone Bridge Co. has the structural iron for about 1¼ miles of the Chicago & South Side Elevated Ry. yet to furnish on its contract for the iron for 3½ miles of that road. This line will be about 10 miles long, when completed. The company is also furnishing the material for the Duluth, Minn., incline railway.

New Companies.—Buffalo Railway Supply Co., Buffalo, N. Y.; capital stock, $100,000; incorporators, S. E. Adams, M. M. Drake, W. S. Clemens, V. H. McConnell. Object, manufacture of frogs and general marine, locomotive and railway supplies. Fisher Movable Frog & Railway Appliance Co., Chicago, Ill.; capital stock, $500,000; incorporators, J. H. Fisher, W. A. Wilmet, J. H. Callahan. Irondale Steel & Iron Co., Anderson, Ind; capital stock, $100,000; incorporators, G. R. Root, D. W. Lovett, G. A. Laughlin, C. Van Camp. Adjustable Incandescent Light Joint Mfg. Co., Chicago, Ill.; capital stock, $50,000; incorporators, J. Long, C. Gaffney, M. W. Clark.

Fire Hydrants.—W. S. Coon, representing the Bourbon Copper & Brass Works, of Cincinnati, O., has been awarded a contract for 90 Bourbon hydrants by the Upper Sandusky, O., Water Co. There was considerable competition to get the contract and the award was made only after a careful examination of the different claims

We reprint the above from our issue of Nov. 1 simply to say that it is evident from later data that some local contention and preferences had to do with "the careful examination" noted above, and the "competition" was narrowed down in proportion.

Metal Market Prices.—*Rails*—New York: $30; $25 for old iron rails. Chicago: $32 to $32.50; old rails, $26 for iron, $17 to $21 for steel. Pittsburg: $29 to $29.50; old rails, $27.25 to $28 for iron, $19 to $19.50 for steel.

Foundry Pig-iron.—Chicago: $15 to $17. Pittsburg $15.50 to $17.25. New York: $16 to $18.

Track Materials.—New York: steel angle bars, $1.65 cts.; spikes, $2 to $2.25; track bolts, 2.75 to 3.15 cts. with hexagon nuts, all New York delivery. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2 to 2.1 cts. for steel; spikes, 2.2 cts.; track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars 2.25 to 2.3 cts. for steel, and 2.1 to 2.2 cts. for iron; spikes, 2.3 to 2.35 cts; iron track bolts $3.10 to $3.15 with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—Chicago, 5.35 to 5.4 cts. New York, 5.25 to 5.75 cts.

Structural Material.—Pittsburg: angles, 2.3 cts.; tees, 2.85 cts.; beams and channels, 3.1 cts.; sheared steel bridge plates, 2.65 to 2.7 cts.; universal mill plates, 2.35 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.1 to 3.2 cts. for flange; 2.9 cts. for shell, 2.5 to 2.55 cts. for tank. New York: beams, 3.10 cts.; plates, 2.25 cts.; angles, 2.1 to 2.25 cts.; tees, 2.6 to 2.7 cts.; channels, 3.1 cts. Chicago: angle, 2.35 to 2.4 cts.; tees, 2.9 to 3.0 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.5 cts.; sheared plates, iron, 2.5 to 2.6 cts.; steel, 2.6 to 2.7 cts.

Proposals for Grading, Improving and Macadamizing County Roads in the County of Richmond.

Sealed Proposals will be received at the place of meeting of the Board of Supervisors of Richmond County, New York, at the Village Hall, Stapleton, Staten Island, until Monday, Nov. 17, 1890, at 3 o'clock, P. M., as follows:

For grading and repairing where necessary and macadamizing or paving with Telford pavement in accordance with the maps, profiles and specifications on file in the Engineer's office, of the following lengths of streets and roads:

Telford pavement, four and one-third (4⅓) miles.

Macadam pavement, sixteen and one-half (16½) miles.

Macadam repairs, four and two-thirds (4⅔) miles.

Total excavation, forty-five thousand (45,000) cubic yards.

Bidders will observe that where Telford pavement is called for, trap, granite, or other equally hard stone only will be used, and in case of macadam pavement and macadam repairs trap rock only will be employed.

Plans and specifications, and also the conditions under which said proposals or bids shall be received, may be examined at the office of William S. Bacot, Engineer of County Roads, Old Village Hall, Stapleton, Staten Island.

Printed copies of the specifications and contract, and also conditions under which said proposals or bids shall be received, may be had at the office of the aforesaid engineer.

The right to reject any or all bids for said work is reserved by said Board of Supervisors of Richmond county as may be deemed for the best interest of the county, and notice is hereby given that the bids will be publicly opened at the meeting of the Board of Supervisors, to be held at the time and place above given.

By order of the Board of Supervisors:

CHAS. M. TODD, Clerk pro tem,
P. O. address, Tompkinsville, S. I.

Dated Oct. 23, 1890. 44-3t

Sealed Proposals.

Proposals will be received until Nov. 10 for furnishing 30 tons 24-in. cast-iron pipe, 900 tons 18-in. cast-iron pipe, 216 tons 14-in. cast-iron pipe, 400 tons 12-in. cast-iron pipe, 40 tons special castings; one compound condensing pumping engine, 3,000,000 galls. capacity; two 100 HP. horizontal boilers, building pumping station, stand-pipe, sinking wells, pipe-laying, etc. Plans and specifications furnished on application to GEO. H. PIERSON,

44-2t Consulting Engineer, Topeka, Kan.

REMOVAL OF SHOALS BETWEEN Sister Islands and Cross-over light, St. Lawrence River, New York. Advertisement. U. S. Engineer Office, Burlington, Vt., Nov. 8th, 1890. Sealed proposals, in duplicate, addressed to the undersigned, will be received at this office until 11:30 A. M., December 9th, 1890, and then publicly opened, for blasting and removing 247 cu. yds. of rock, more or less, from two shoals between Sister Island and Cross-over light, St. Lawrence River, N. Y. Attention is invited to the Acts of Congress approved Feb. 26th, 1885, and Feb. 23d, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Detailed information can be had on application. M. B. ADAMS, Major of Engineers.

45-2t 48-1t

U. S. ENGINEER OFFICE, BURLINGTON, Vt., Nov. 8, 1890. Sealed proposals, in duplicate, addressed to the undersigned, will be received at this office, until 11:30 A. M. Dec. 9th, 1890, and then publicly opened, for furnishing 182,886 ft. b. m. of hemlock timber; 9,600 feet b. m. of white pine timber; 3,000 cu. yds. of rubble stone; 7,750 cu. yds. of large stone, 1 to 5 tons weight; 1,208 pounds of screw and washer bolts; 546 pounds of ring bolts, 23,441 pounds of drift bolts, and constructing 300 lin. ft. of extension and repairing, 1,225 lin. ft. of old superstructure to the breakwater at Plattsburgh Harbor, New York. Preference will be given to materials of domestic manufacture or production, conditions of quality and price (import duty included) being equal. Attention is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Detailed information can be had on application. M. B. ADAMS, Major of Engineers.

45-2t 48-1t

Gate Valve.

WANTED, one 30-in. gate valve, new or second-hand. Must stand 8 to 10 lbs. pressure.

Address

SUPERINTENDENT,
Caldwell Water-Works,
Caldwell, Kan.

45-1t.

S. E. NOBLE, Prest. JNO. E. WARE, Secy. and Treas. R. F. CARTER, Supt.

The Anniston Pipe Works,

MANUFACTURERS OF

CAST IRON WATER AND GAS PIPE,

ANNISTON, - - - - ALA.

Especially adapted for the Elevation of Clear, Gritty, Thick, or Acidulous Liquids, Quickly, Cheaply and Efficiently

PATENTED U. S. AND CANADA.

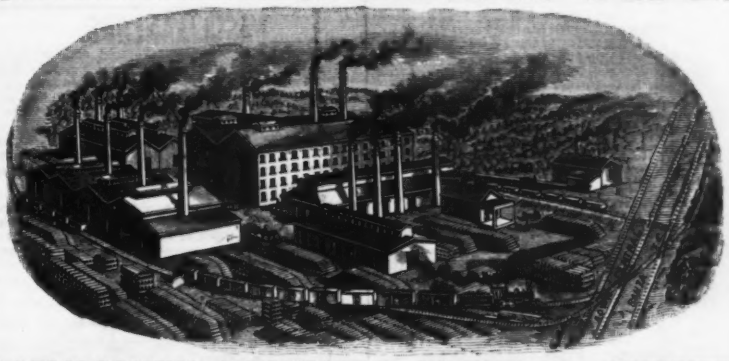
THE NEW PULSOMETER STEAM PUMP.

without Engine, Machinery, Oil, Expensive Power, Skilled Labor, or Material Wear. Send for Illustrated Catalogue.

PULSOMETER STEAM PUMP CO., 120 Liberty St., New York.

DOUBLE STRENGTH

SEWER & CULVERT PIPE.



MONMOUTH MINING & MFG. CO., MONMOUTH, ILL.

Proposal—Seventh Street Sewer.

In pursuance of the provisions of a certain ordinance of the city of Rockford, Ill., passed on the third day of November, 1890, the undersigned will receive sealed proposals for furnishing materials and constructing a sewer in said city, beginning at the south line of Charles St., and extending in a southerly direction in Seventh St., 2,880 feet, to a point of connection with the Keith's Creek sewer on Eighth Ave., as described in said ordinance.

Said sewer must be constructed in substantial compliance with the terms of the ordinance ordering its construction, and in accordance with plans and specifications on file at the office of the City Engineer.

Bids may be filed at the office of City Clerk, accompanied by a certified check equal to 10 per cent. of the amount of bids, on or before Nov. 29, 1890, at 12 o'clock noon.

Seven (7) man-holes, eight (8) catch-basins, 6 on 15-in. Y-branches as directed. Size of sewer 15 ins.

The city reserves the right to reject any or all bids.

E. K. CONKLING, City Clerk.

ROCKFORD, Ill., Nov. 4, 1890. 45-1t.

To Contractors.

PHILADELPHIA, Nov. 6th, 1890.

Proposals for constructing wrought-iron western approach to Walnut street bridge, will be received by LOUIS WAGNER, Director of the Department of Public Works, at this office until 12 o'clock, noon, Monday, Nov. 17th, 1890.

Specifications are the same as former advertisement. Proposals must be accompanied by a certificate that a bond for $500, has been filed in the Department of Law, Sixth and Locust streets.

Blue print copies of the plans on exhibition here may be obtained by those first applying, upon payment of $5, to the Receiver of Taxes.

J. MILTON TITLOW,
45-1t Prin. Assistant Engineer.

FOR SALE.

One twenty-ton Aveling & Porter steam road roller, in good repair.

Apply to

CHARLES W. SPRAGUE,
Supt. of Streets,
44-2t Hartford, Conn.

Iron Bridges for Sale.

Four trussed I-beam girders of substantial build, removed because present traffic makes heavier bridges necessary, are offered for sale:

Two spans, 42 ft. 9 ins. long.
5 ft. 6 ins. deep C. to C. of pins.
4 ft. 11 ins. wide C. to C.

Two spans, 42 ft. 9 ins. long.
5 ft. 0 ins. deep C. to C. of pins.
7 ft. 0 ins. wide C. to C.

Can be seen at Aurora, Ill. Apply to Purchasing Agent C., B. & Q. R. R., Chicago, Ill.

44-3t

Toronto Water-Works.

PROPOSALS FOR PUMPING MACHINERY AND BOILERS.

Sealed proposals will be received by the trustees of water-works of the city of Toronto, Jefferson Co., O., at their office in said city until 12 o'clock noon, of Wednesday, Dec. 3, 1890, for furnishing vertical pumping machinery having the capacity to pump 3,000,000 United States galls. of water per 24 hours, from the Ohio River, the source of supply, to the Walker Hill reservoir, some 3,000 ft. distant, and with an altitude of approximately 325 ft. above the surface of low water in said river.

Bids will be received for one or more pumping engines of above capacity, and also for one or more pumping engines each with capacity to pump 1,500,000 galls. under like conditions as above, the trustees reserving the right to accept either, after receiving bids for same.

Also for two return tubular boilers, each 5 ft. diameter and 14 ft. long, including foundations and the placing the machinery thereon, together with all pipes, valves and fixtures for both steam and water, inside the building. Also including boiler foundations, settings and fixtures complete.

General specifications, forms of proposals and forms of contract will be furnished from and after Nov. 15, 1890.

The right to reject any or all bids is hereby reserved. O. Y. CRAWFORD,
Trustee and Secretary.

J. D. COOK, Toledo, O., Consulting Engineer.

TORONTO, Ohio, Oct. 28, 1890. 45-1t

AT A SACRIFICE.

A complete cotton factory with latest improved machinery, with thirty acres of beautifully located land, in one of the most flourishing young cities in Southwest Texas for Sale. Land alone worth half the money. Write for particulars to

RANNEY & MONTGOMERY,
42-4t Yoakum, Tex.

Artesian Well.

CITY OF CHARLESTON WATER-WORKS CO., GEORGE ST., CHARLESTON, S. C., Oct. 13, 1890.

Proposals are invited for sinking an artesian well in the city of Charleston, S. C.

The depth of the well to be not less than 2,000 ft., with a minimum diameter of 6 in. at the maximum depth.

All proposals must be forwarded by the first day of December next.

Full particulars will be furnished on application to the undersigned.

ZIMMERMAN DAVIS,
42-7t Secretary and Treasurer.

Ore Dock.

OFFICE OF IRON RANGE & HURON BAY R. R. CO., ARVON, Mich., Oct. 8, 1890.

Proposals will be received at this office for the furnishing of the labor and material for the construction of an Ore Dock for the Iron Range & Huron Bay R. R. Co. on Huron Bay, Lake Superior, Baraga county, Mich., until 12 o'clock noon, Nov. 15, 1890.

There will be about 2,000,000 ft. B. M. of timber and 3,000 piles.

Plans and specifications can be seen at this office. The right to reject any or all bids is reserved.

MILO DAVIS,
42-4t Chief Engineer.

Pumping Engines.

Sealed proposals will be received at the office of the Board of Water Commissioners, Norfolk, Va., until noon of Saturday, Nov. 15th, 1890, for one ten million gallon pumping engine and one five million gallon pumping engine.

Bids will be received for either direct acting crank and fly-wheel or vertical single compound or triple expansion condensing engines.

Detailed specifications can be had at the water-works office.

By order of the Board of Water Commissioners.

45-1t.

Notice to Contractors.

SUSPENSION BRIDGE, N. Y., Oct. 29, 1890.

Sealed proposals will be received by Leander Colt, President of the Board of Sewer Commissioners of Suspension Bridge, N. Y., until Tuesday evening, Nov. 18, 1890, 6:00 P. M., for the construction of sewers in the village of Suspension Bridge, County of Niagara, State of New York, as follows:

Section 1.—About 890 ft. egg-shaped brick, 3 × 2 ft. or 890 ft. 30-in. tile; 560 ft. 24-in., 690 ft. 20-in., 560 ft. 18-in., 2,040 ft. 15-in., 1,030 ft. 12-in.

Section 2.—About 750 ft. 24-in., 190 ft. 18-in., 310 ft. 12 in., with man-holes, basins, inlets and all appurtenances.

Bids will be received for one or both sections.

Each bid must be accompanied by a bond or certified check of one thousand dollars ($1,000).

The right to reject any or all bids will be reserved by the Board. Full information as to plans, specifications, etc., can be obtained from the Engineer of the Board, W. C. Johnson, at his office, No. 170 Main St., Niagara Falls, N. Y.

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L. W. SWAN,
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180 miles on the Macon & Atlantic R. R. on November 15th, 1890, also 40 miles station work, J. S. McTIGHE & Co., 316 Pine Street, Macon, Ga. 43-2t

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For bridges, trestles, and car building. Mills in belt of the finest South Georgia yellow pine timber. Orders promptly filled. Address, C. J. HADEN,
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(For other Proposals See Pages XXII, XXIII and XXVII.

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R. E. HARDAWAY, Chief Engineer.

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DEAR SIRS: I used four of your lights for steam shovel work at night some time since and they gave entire satisfaction.

Yours very truly,
B. E. HARDAWAY, C.E.

(Copy.)

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WESTON, W. Va., June 24, 1890.

Messrs. Keegan & Halpin, 46 Washington Street, New York:

GENTLEMEN: Replying to your favor of 21st inst., the light you sent us has thus far given satisfaction, and I can see no chance for improvement in it.

Yours truly,
J. A. FICKINGER, Ch. Eng.

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Carkin, Stickney & Crane;
C. H. & F. T. Dunbar;
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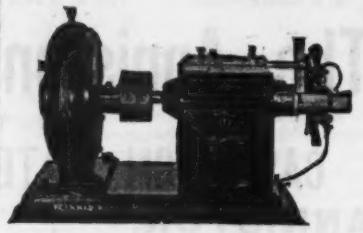

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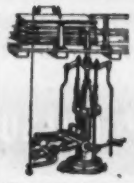

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WANTED.—An engineer to fire two 60 in. × 16 ft. boilers and run a Deane compound pump. Also a practical water-works superintendent to take charge of small plant in Indiana. Middle-aged men (married) preferred. Address, with full particulars of experience and wages expected, IRON, care Engineering News. 44-2t

WANTED.—Two experienced draughtsmen for making shop drawings; state salary and experience. W. B. & I. CO., Wauwatosa, Milwaukee Co., Wis. 45-1t

MISCELLANEOUS.

WANTED.—2,000 bbls. Portland cement, delivered on boat at New Orleans about Nov. 15. Tensile strength, 300 lbs. one day in air, six days under water. McCORMICK & O'MEARA, 904 Olive St., St. Louis, Mo. 40-

WANTED.—We will send a copy of "Cross' Engineer's Field Book" in exchange for ENGINEERING NEWS of Oct. 4, 1890. Address Engineering News.

WANTED.—To buy a new or second-hand stone crusher, suitable for making sand from sand rock. Address F. C. NEEB, Lancaster, O. 45-1t

UTILIZATION.

Foreman of Daily Paper—This cut of "Before Using Higgin's Salve" is flattened out so it won't print.

Editor—Run it in on the first page and mark it "Mrs. Langtry in the dark;" we've got to fill space to-day, anyhow.—*Judge.*

Contract Drawings of the New Croton Aqueduct.

From Croton Dam to Harlem River.

Plates 1 and 2.—Map and profile showing the route of the new Croton Aqueduct, location of shafts blow-off and waste weirs, also route of the present aqueduct.

Plate 3.—Sheet No. 11, general form of aqueduct at north side of Harlem River. Sheet No. 3¼ shows beginning of aqueduct at Croton River.

Plate 4.—Sheets No. 4, 4½ and 16 show tunnel excavation and masonry in various kinds of material.

Plate 5.—Sheet No. 5, Figs. 1 and 2, also sheet No. 6, show aqueduct under pressure in rock tunnel. Sheet No. 6¼ shows aqueduct where it is in rock tunnel.

Plate 6.—Sheets Nos. 7 and 7½, general form of aqueduct in rock tunnel.

Plate 7.—Sheets Nos. 8, 8¼ and 8½, aqueduct without masonry, except floor. Sheet No. 25, aqueduct in earth and rock, water pressure overhead.

Plate 8.—Sheets Nos. 9 and 9½, tunnel excavation and masonry.

Plate 9.—Sheets Nos. 17, 18 and 20, aqueduct in rock tunnel. Sheets No. 19, Fig. 1, aqueduct on flooring. Fig. 2, on piles.

Plate 10.—Sheet No. 21, aqueduct in compact and loose rock. Sheets Nos. 22 and 23, aqueduct in earth. Sheet No. 24, aqueduct in tunnel requiring support.

Plate 11.—Sheet No. 13, shaft for aqueduct under pressure, south of Yonkers.

Plate 12.—Sheet No. 14, shaft for aqueduct under pressure, south of Yonkers.

Plate 13.—Sheet No. 15, masonry for shafts aqueduct not under pressure.

Plate 14.—Sheet No. 31, blow-off and waste weir, to be built at South Yonkers.

Plate 15.—Sheet No. 28, blow-off and waste weir at Ashford on Saw Mill River.

Plate 16.—Sheet No. 26, blow-off and waste weir at Pocantico River.

Also, table of bids and prices.

This Volume of Drawings was prepared and published by the Chief Draughtsman of the New Croton Commission in 1885. They are photographic reproductions of the working drawings, reduced to a page 9 inches by 12 inches, each sheet being signed by the Chief Engineer, B. S. Church.

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SITUATIONS WANTED.

WANTED.—An engineer who expects soon to finish his present engagement desires position on location, construction or maintenance of way. Twenty years experience; 40 years old. Address C. E., Engineering News. 36—

WANTED.—TO CAPITALISTS AND INVESTORS—A civil engineer of experience in the location, construction, equipment, and operation of railways wants an engagement with capitalists in developing NEW RAILWAY LINES. Will furnish first-class references. Address R. W., care of Engineering News. 38-3t

WANTED.—A gentleman with large experience in manufacturing and water-works superintendency in New York, wishes to correspond with parties or contracting firm needing the services of a general superintendent or manager. Will travel or take office. Is a pusher and can handle any work. Age 47. Can engage after Nov. 1. A1 references. Address HOVEY, care Engineering News. 40-

WANTED.—Bridge engineer, now employed on bridge estimates, with experience in railroad and highway bridge calculation, design and draughting, also in iron roof truss work, will be open for engagement to take effect Jan. 1, 1891. Any reference desired can be given from present or former employers. JUN. AM. SOC. C. E., 541 Flower St., Los Angeles, Cal. 43-3t

WANTED.—An engineer who has had several years experience, desires a position on a railway, either on location, construction or maintenance of way; is willing to go to any part of the country. Owns good instruments, and can furnish first-class references. Thirty years old. Address T. P., care of Engineering News. 44-1t

WANTED.—Work by a graduate civil engineer of Cornell University, with 10 years practical experience on railway construction, maintenance of way and city work. Best of references. Address CIVIL ENGINEER, 211 E. Franklin St., Warren, O. 44-3t

WANTED.—By a gentleman about to open a manufacturers' agency, correspondence with manufacturers desirous of being represented in Canada; security given. D. W. C., 307 Sherbourne street, Toronto, Canada. 44-3t

WANTED.—An experienced locating, construction and bridge engineer competent to design and construct bridges, roofs, masonry and all heavy railway work, is open to an engagement. Address "X," Engineering News. 45-1t

WANTED.—Position by an energetic man, experienced in the location of railroads; leveling preferred; has been surveying lines in Australia; has own level; can give reference. Address EDWARDS, 607 Ellis St., San Francisco, Cal. 45-3t

WANTED.—A young man desires a position as an assistant resident engineer or instrument man. Has had 18 months' experience in England. Graduate of an English college. Can give good references. Address M. A. N., care Engineering News. 45-3t

WANTED.—A young man, at present assistant engineer, with four years' experience in railroad engineering, desires situation; references given. Address A. B. C., care of Engineering News. 45-3t

WANTED.—Experienced contractor's accountant, clerk or timekeeper wants work; age 28; 4 years with aqueduct contractors; best references; can manage office or do rough work. Address SOBRIETY, care of Engineering News 45-3t

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